Equipment Packet: Oxygen Concentrator

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Equipment Packet Contents:

This packet contains information about the operation, maintenance, and repair of oxygen concentrators.

Part I: External From the Packet:

1. **An Introduction to Oxygen Concentrators:** PowerPoint

Part II: Included in this Packet:

1. Operation and Use of Oxygen Concentrators

Featured in this Section:

Malkin, Robert. “Oxygen Concentrators.” *Medical Instrumentation in the Developing World*. Engineering World Health, 2006.

Strengthening Specialised Clinical Services in the Pacific. *User Care of Medical Equipment: A first line maintenance guide for end users*. (2015).

Wikipedia. “Oxygen Concentrator.” *Wikipedia*, p. 1-5. Retrieved from: https://en.wikipedia.org/wiki/Oxygen_concentrator

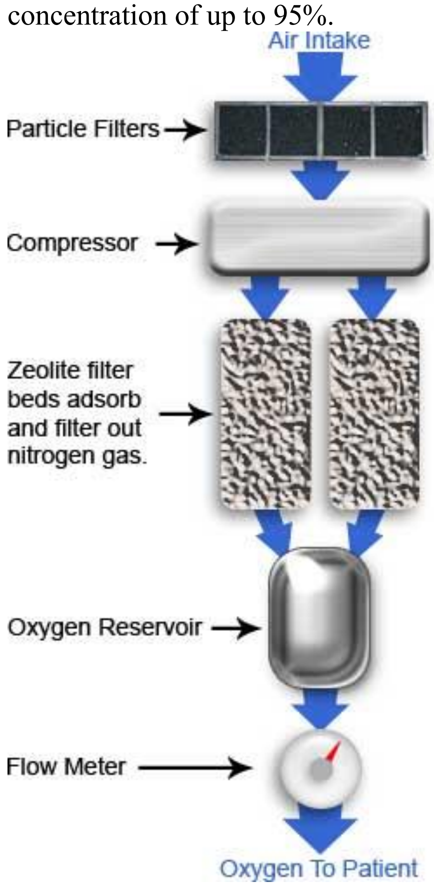
Chapter 4.12 Oxygen Concentrators

Function

An oxygen concentrator draws in room air, separates the oxygen from the other gases in the air and delivers the concentrated oxygen to the patient. When set at a rate of two litres per minute, the gas that is delivered by the concentrator is more than 90% oxygen. It is used for situations where bottled gas supply is impractical or expensive, and can be used by patients in the hospital or the home.

How it works

Atmospheric air consists of approximately 80% nitrogen and 20% oxygen. An oxygen concentrator uses air as a source of oxygen by separating these two components. It utilizes the property of zeolite granules to selectively absorb nitrogen from compressed air. Atmospheric air is gathered, filtered and raised to a pressure of 20 pounds per square inch (psi) by a compressor. The compressed air is then introduced into one of the canisters containing zeolite granules where nitrogen is selectively absorbed leaving the residual oxygen available for patient use. After about 20 seconds the supply of compressed air is automatically diverted to the second canister where the process is repeated enabling the output of oxygen to continue uninterrupted. While the pressure in the second canister is at 20 psi the pressure in the first canister is reduced to zero. This allows nitrogen to be released from the zeolite and returned into the atmosphere. The zeolite is then regenerated and ready for the next cycle. By alternating the pressure between the two canisters, a constant supply of oxygen is produced and the zeolite is continually being regenerated. Individual units have an output of up to five litres per minute with an oxygen concentration of up to 95%.



Oxygen concentrator

An **oxygen concentrator** is a device used to provide oxygen therapy to a patient at substantially higher concentrations than available in ambient air. They are used as a safer, less expensive, and more convenient alternative to tanks of compressed oxygen. Common models retail at around US$800. Leasing arrangements may be available through various medical-supply companies and/or insurance agencies.

Oxygen concentrators are also used to provide an economical source of oxygen in industrial processes.

A home oxygen concentrator *in situ* in an Emphysema patient's house. The model shown is the DeVILBISS LT 4000.

How they work

The simplest oxygen concentrator is capable of continuous delivery of oxygen and has internal functions based around two cylinders, filled with a zeolite material, which selectively adsorbs the nitrogen in the air. In each cycle, air flows through one cylinder at a pressure of around 20 lbf/in² (138 kPa, or 1.36 atmospheres) where the nitrogen molecules are captured by the zeolite, while the other cylinder is vented off to ambient atmospheric pressure allowing the captured nitrogen to dissipate.

Typical units have cycles of around 20 seconds, and allow for a continuous supply of oxygen at a flow rate of up to approximately five liters per minute (LPM) at concentrations anywhere from 50 to 95 %. This process is called pressure swing adsorption (PSA).[1] Since 1999, concentrators providing up to 10 LPM have been available for high flow patients, in sizes not much larger or heavier than 5 LPM concentrators.

An Invacare Perfecto 2 oxygen concentrator

Portable oxygen concentrators

Since 2000, a number of manufacturers have introduced portable oxygen concentrators. Typically, these produce less than one liter per minute (LPM) of oxygen and use some version of pulse flow or demand flow to deliver oxygen only when the patient is inhaling. However, there are few portable oxygen concentrators that produce 3 LPM of continuous-flow oxygen. Also providing pulse flow available to either provide higher flows or reduce power consumption. These portable concentrators typically plug into a wall outlet like the larger, heavier stationary concentrators. [2]

Portable oxygen concentrators usually can also be plugged into a vehicle DC adapter, and most have the ability to run from battery power as well, either for ambulatory use or for use away from power or for airplane travel. The FAA has approved portable oxygen concentrators for use on commercial airlines, although it is necessary to check in advance whether a particular brand or model is permitted on a particular airline.

Historically, demand or pulse flow concentrators have not been used for nocturnal use—sleeping. If the nasal cannula moves such that the concentrator is not able to detect when the patient is inhaling, it is unable to deliver the pulse while the patient is inhaling.

Military uses

Oxygen concentrators are currently being used by the US military in the conflicts in Iraq and Afghanistan as part of the equipment complement of forward surgical teams.

Safety

In both clinical and emergency-care situations, oxygen concentrators have the advantage of not being as dangerous as oxygen cylinders, which can, if ruptured or leaking, greatly increase the combustion rate of a fire. As such, oxygen concentrators are particularly advantageous in military or disaster situations, where oxygen tanks may be dangerous or infeasible.

Oxygen concentrators are considered sufficiently non-volatile to be leased to individual patients as a prescription item for use in their homes. Typically they are used as an adjunct to CPAP treatment of severe sleep apnea. There also are other medical uses for oxygen concentrators, including emphysema and other respiratory diseases.

Used, refurbished, and temperamental units are worthless to the medical community since an individual's health frequently relies on the constant extended operation of the unit. However, such units are valuable to metal and glasswork hobbyists. Oxygen is one of the more expensive bottled gases. Medical oxygen concentrators or dedicated industrial (non-medical) oxygen concentrators can be made to operate a small oxy-acetylene torch quite easily, if only at lower pressures.[3]

Industrial oxygen concentrators

Industrial processes may use much higher pressures and flows than medical units. To meet that need, another process, called vacuum swing adsorption (VSA), has been developed by Air Products. It uses a single low pressure blower and a valve which reverses the flow through the blower so that the regeneration phase occurs under a vacuum. Generators using this process are being marketed to the aquaculture industry.[4] Industrial oxygen concentrators are often available in a much wider range of capacities than medical concentrators.

Industrial units are sometimes referred to as oxygen *generators* within the oxygen and ozone industries to disambiguate from medical oxygen *concentrators*. The distinction is used in an attempt to clarify that industrial oxygen concentrators that are not FDA-approved medical devices are not suitable for use as bedside medical concentrators. However, applying the oxygen generator nomenclature can lead to confusion. The term, oxygen *generator,* is a misnomer in that oxygen is not *generated* as it is with a chemical oxygen generator, but rather is concentrated from the air. The use of the oxygen generator terminology can also be a problem for shipping logistics in the wake of the ValuJet Flight 592 crash. Non-medical oxygen concentrators can be used as a feed gas to a medical oxygen system, like a hospital oxygen system, although FDA (or other region-specific regulatory, like CE) approval is required, additional filtration is generally required, and there may be other regulatory requirements as well.

See also

- Portable oxygen concentrator
- The section on Storage and Sources of Oxygen in the Oxygen therapy article.

Notes

[1] (http://www.airoxnigen.com/psa_oxygen.htm)
[2] "Sequal" (http://www.sequal.com/medical.php). Sequal. . Retrieved 2010-04-30.
[3] (http://pyronamix.com/page6.html)
[4] http://www.airproducts.com/Products/Equipment/PrismGasGenerationSystems/Prism_oxygen/adsorption_process-description.htm

- 5. Airsep Website (http://www.airsep.com/)

Article Sources and Contributors

Oxygen concentrator *Source*: http://en.wikipedia.org/w/index.php?oldid=359235268 *Contributors*: Afaprof01, Airplaneman, Andrewjlockley, BanyanTree, Bobblewik, BrokenSphere, Bryan Derksen, Captain-n00dle, DabMachine, Donfbreed, Fisharmor, Fluidcreativity, GiollaUidir, HiEv, Intermedical, John, KayDee, Kerowyn, Ksooder, Lg king, Metrax, Mini-Geek, Mscott0, NCurse, No1anyoneknows, Oldlaptop321, Pearle, Poodleboy, PurpleHz, R. S. Shaw, Ranchoschmitz, Rjwilmsi, Robert A West, Russkeller, Sbmehta, Smilerehab, Tenorcnj, Tmonzenet, Wavelength, Wdfarmer, Weregerbil, WmRowan, 31 anonymous edits

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2.3 Oxygen Concentrators

2.3.1 Clinical Use and Principles of Operation

Oxygen is a widely prescribed medication in both the hospital and home setting. Hypoxia, or an inadequate amount of oxygen, is the main physiological state requiring this medical technology and is present in a number of life-threatening conditions. These include chronic obstructive pulmonary disease (COPD), which refers to the restriction, inflammation, or infection of bronchioles or alveoli whereby oxygen supply or transfer to the blood is limited. Cardiovascular insufficiency also causes hypoxia when an irregular rhythm, decreased flow, or inefficient transport prevents adequate oxygen delivery to peripheral tissues.

In addition to these medical conditions, a reliable source of oxygen is essential wherever anesthetics are administered, both to supplement the inspired gas mixture and also for resuscitation, though other machines such as ventilators may be selectively used.

Oxygen has traditionally been supplied in cylinders in the developing world. However, cylinders are both bulky and expensive. In isolated areas transportation of cylinders is difficult and may be unreliable. For these reasons, The World Health Organization recommends oxygen concentrators as a better long-term investment for smaller, remote hospitals in the developing world.

Engineering Details

Ambient air contains 78% N, 21% O2 and 1% trace gases. An oxygen concentrator works by separating and removing the nitrogen from the ambient air, leaving nearly pure (95%) oxygen. At high flow rates the oxygen concentration may drop.

Most machines now operate using pressure swing adsorption (PSA). Ambient air is compressed and passed through a synthetic aluminum silicate (zeolite). Zeolite acts as a molecular sieve by binding to nitrogen, but only at high pressures. The zeolite is designed with a porous configuration to maximize surface area.

The high pressure, concentrated, oxygen is stored in a tank. A pressure regulator is used to step down the pressure to the desired range.

After the zeolite is saturated with nitrogen, the valve leading to the oxygen tank is closed and the pressure is decreased in the zeolite tank. As the pressure drops the zeolite releases nitrogen which is vented into the air. A small quantity of enriched oxygen is then passed backwards through the zeolite canister to completely purge the zeolite of nitrogen. Since the patient probably needs a continuous supply of oxygen, a typical concentrator will have two zeolite canisters. One is concentrating oxygen while the other is being purged.

An oxygen concentrator is easy to operate with only a power switch and a flow meter. An alarm sounds if the pressure in the compression chamber falls below 20 psi. Some models include a built-in device called an OCSI (oxygen concentration status indicator) that measures the oxygen concentration just before the outlet. An alarm would sound if the concentration is low in these devices. Some machines automatically shut down if the concentration of oxygen falls below 70%.

2.3.2 Common Problems

Concentrators do malfunction occasionally, and their repair can require considerable expertise; worn parts on the compressor and valves may need replacement. Assuming that all other parts function optimally, the machine is only limited by the life of the zeolite crystals, which is expected to be at least 20,000 hours.

The primary complaints are low oxygen concentrations and decreased gas flows. Since this machine is so widely used and has few options on the interface, user error is unlikely. A clogged filter may be the cause. The filter is located between the air source and the zeolite containers. Some models may have multiple filters. A dirty filter can lead to a decreased oxygen concentration and/or a decreased flow rate.

If the flow to the patient is insufficient, the tubing and connectors should be checked for leaks. Remember that part of the oxygen-providing pathway from the zeolite canisters can be inside of the machine.

If the motor or compressor is not functioning properly, air in the zeolite canisters will not be pressurized enough to remove an adequate amount of nitrogen from the air. It is necessary in this case to check any seals/gaskets associated with these systems. Inside the chambers, 20psi is the standard pressure.

The valves at the inlet and outlet of the zeolite canisters must be tight and timed correctly. During pressurization, the inlet valve should be opened and the outlet valve should be closed. During filtering, which normally takes 8 to 20 seconds, both valves should be closed as nitrogen binds to the zeolite. During release of oxygen-concentrated air to the patient, only the outlet valve should be opened. Remember that in the regeneration stage a small amount of oxygen is released back into the canister to expel leftover nitrogen. Most models have valves that are coordinated between chambers. However, check the timing of valve opening and closing. Canisters will be in different stages of the pressure swing cycle so that while one canister is filtering, the other is regenerating.

2.3.3 Suggested Minimal Testing

It is important that this machine achieve oxygen concentrations near 90% or above and provide gas flows in the manufacturer's range, keeping in mind that for high flow rates (around 5 liters/minute) oxygen concentration will be lower. In addition, it is not safe to trust flow meters and oxygen concentration indicators on the machine when releasing an oxygen concentrator to the floor. These variables need to be checked using a separate oxygen analyzer and flow meter, respectively. It is not typically difficult to determine the flow rate in the developing world, as there is an abundance of flow meters. However, measuring oxygen concentration can be challenging. If you are unable to locate an oxygen concentration meter, discuss the problem with the physician before releasing the device to the floor without an oxygen concentration test. The measurement must be performed 10 minutes after switching the concentrator on to give the machine time to build up the concentration of oxygen.

Malkin, Robert. "Oxygen Concentrators." Medical Instrumentation in the Developing World. Engineering World Health, 2006.

2. Diagrams and Schematics of Oxygen Concentrators

Featured in this Section:

Developing World Healthcare Technology Laboratory. “Oxygen Monitors.” From the Publication: “Biomedical Technicians Training Program, Session 3 v2, Special Topics: Cardiac Equipment.” *Engineering World Health*, March 1, 2011, p. 115-159.

Skeet, Muriel and David Fear. “Oxygen Concentrators.” *Care and Safe Use of Medical Equipment*. VSO Books, 1995.

Figure 1: An Oxygen Concentrator in Operation

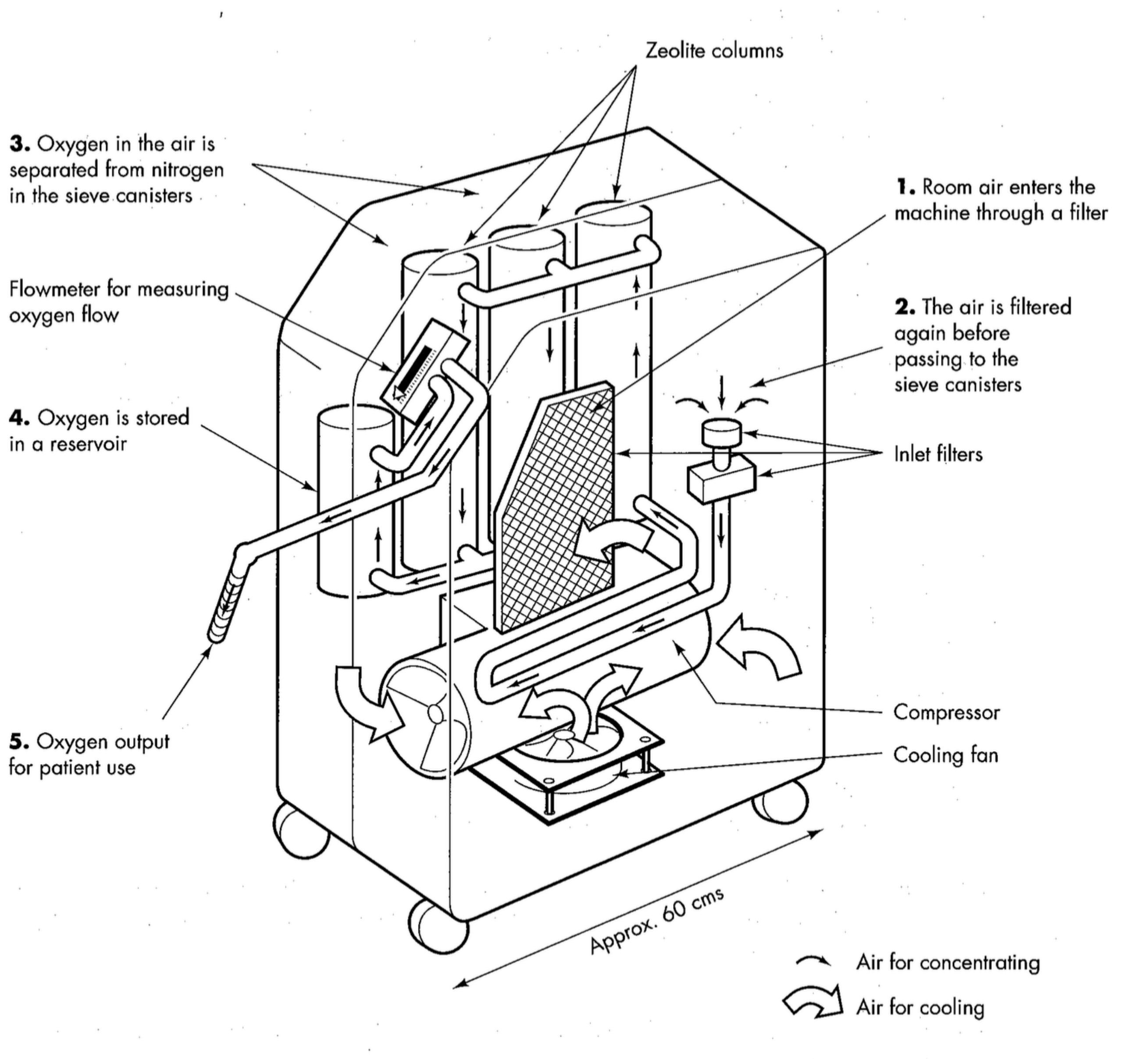
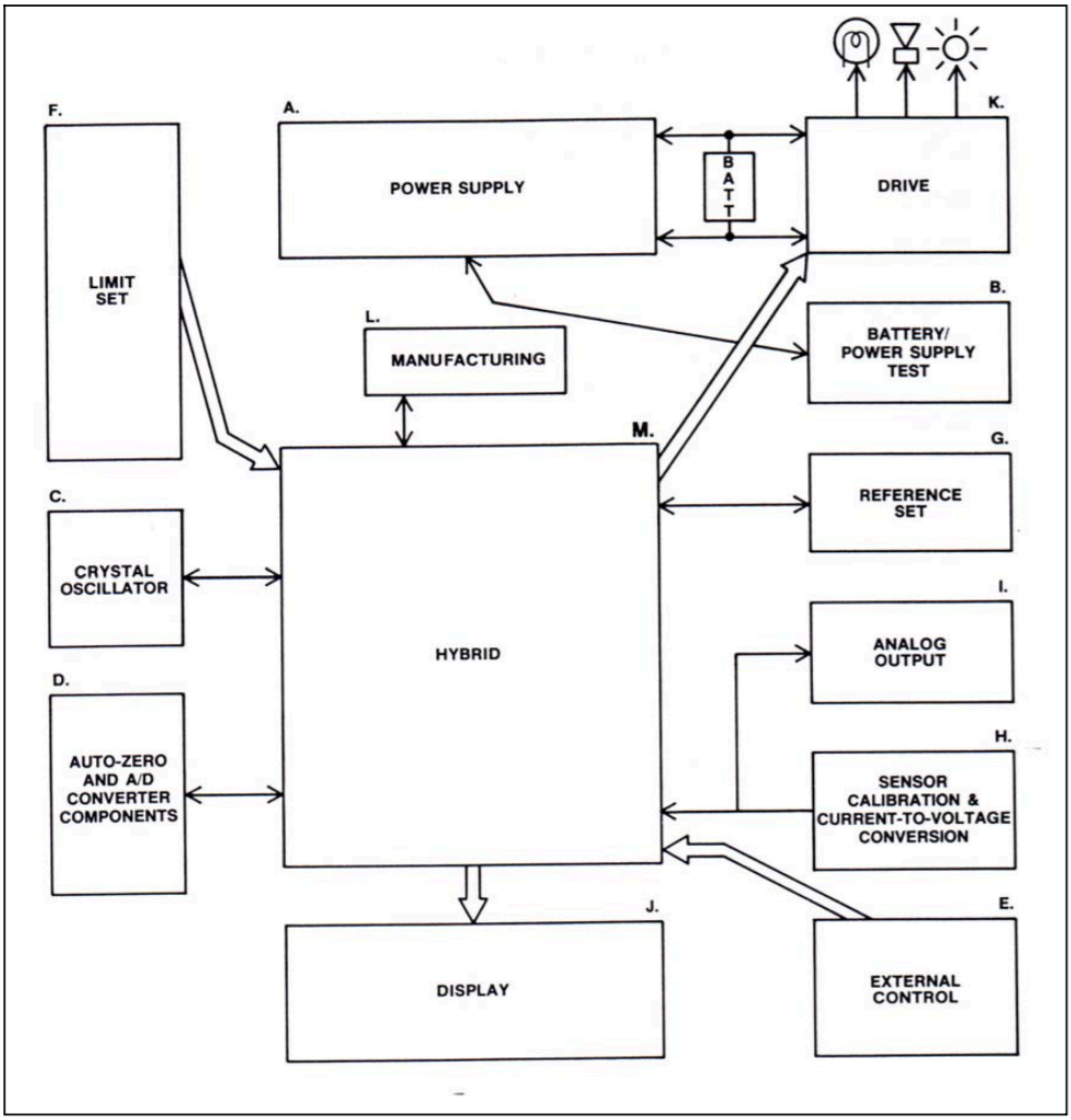


Figure 20: Oxygen concentrator in operation

Skeet, Muriel and David Fear. "Oxygen Concentrators." Care and Safe Use of Medical Equipment. VSO Books, 1995.

Figure 2: Block Diagram of an Oxygen Concentrator



Block Diagram – Oxygen monitor

Developing World Healthcare Technology Laboratory. "Oxygen Monitors." From the Publication: "Biomedical Technicians Training Program, Session 3 v2, Special Topics: Cardiac Equipment." Engineering World Health, March 1, 2011, p. 115-159.

3. Preventative Maintenance and Safety of Oxygen Concentrators

Featured in this Section:

Cooper, Justin and Alex Dahinten for EWH. “Oxygen Concentrator Preventative Maintenance.” From the publication: *Medical Equipment Troubleshooting Flowchart Handbook*. Durham, NC: Engineering World Health, 2013.

DHT Laboratory. “Oxygen Concentrator Measurement.” From the publication: Biomedical Technician Assistant (BTA) Skills, Duke University: DHT Lab, 2011.

EQUIPMENT

Oxygen Concentrator Preventative Maintenance

Preventive Maintenance

Always run machine for a few hours after maintenance before patient use

1. Clean humidifier and tubes
    a. Wash in warm soapy water, rinse thoroughly, and replace
2. Change distilled water
3. Remove and clean the foam air intake filter
    a. Wash with soap and water
    b. Ensure filter is dry *before* replacing but *do not* use heat to dry
4. Check Alarm system battery
    a. An audible alarm should sound when the machine is turned on
    b. Replace 9V battery when necessary
5. Check if Zeolite Canisters have expired (25,000 hours). The granules become grey when they are no longer effective.
6. Felt pre-filter should be changed once a month (if available)
7. Replace patient bacterial filter annually (if available)

Oxygen Concentrator Calibration and Measurment

Knowledge Domain: Mechanical
Unit: Calibration
Skill: Oxygen Concentration Measurement

Tools and Parts Required:

1. **Wide basin or pan**
2. **Water**
3. **Adhesive substance** eg. putty, chewing gum or gluestick
4. **Glass Bottle** 90-220ml,eg.food jar, beaker (must be glass).
5. **Aluminum foil** Enough to cover mouth of bottle
6. **Small candles** ~75% bottle height, much narrower than mouth of bottle
7. **Lighter or matches**
8. **Electrical tape**
9. **Wooden stick** <4cm, narrower than mouth of bottle
10. **Volume measurer** eg. graduated cylinder, syringe, or measuring cups
11. **Dishwashing soap**
12. **Spreading utensil** eg. butter knife
13. **Marker**
14. **Pencil**
15. **Paper**
16. **Safety goggles (optional)**
17. **Heat-resistant gloves (optional)**
18. **O_2 Concentrator or O_2 Cylinder with tubing**

Introduction

This test measures the concentration of oxygen in a sample of air. This test can be used to measure the output oxygen concentration of an oxygen concentrator. Oxygen concentrators must be tested to insure that they are functioning properly.

Identification and Diagnosis

An oxygen concentrator device provides concentrated oxygen to the patient. It is important to know that the device can deliver concentrated oxygen. Use this method to measure the concentration of oxygen provided by the oxygen concentrator. The measurement is based on a change in the volume of gas that occurs during a combustion reaction. Record the measurements on a piece of paper. You may want an assistant for help.

DHT Laboratory. "Oxygen Concentrator Measurement." From the publication: Biomedical Technician Assistant (BTA) Skills, Duke University: DHT Lab, 2011.

Procedure

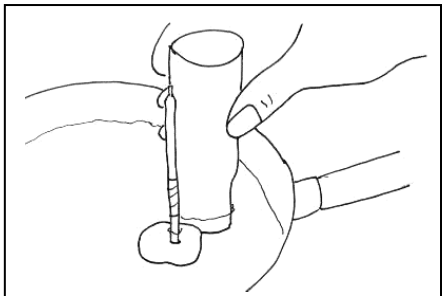
Preparation

1) Find a glass bottle that holds 90 to 220 ml of liquid. You can use a lab beaker, or any food jar, such as pickle, jam, peanut butter jars.
   - The bottle must be glass. Plastic will melt and change shape with the candle flame. The oxygen measurement will not be accurate with a plastic bottle.
   - The bottle must be between 90-220 ml. This volume range has been tested for accuracy. If your bottle is larger or smaller, the oxygen measurement will not be accurate.

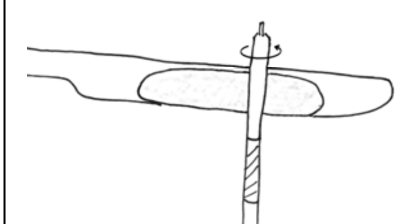
2) Find a candle of appropriate height and thickness.
   - The candle height must be 75% of the bottle height. If the candle is too short, extend the candle by taping a wooden stick to the candle. If the candle is too long, cut off the top end with a heated butter knife or scissors.
   - The candle should fit into the mouth of the bottle. If the candle is too thick, use the butter knife to scrape the candle in a rotating motion until it is the correct size.

3) Using a knife or other spreading utensil, apply dishwashing soap to the candle. The soap protects the wax from burning too quickly. If you do not soap the candle, it will flame too quickly. **Do not soap the wick of the candle.**

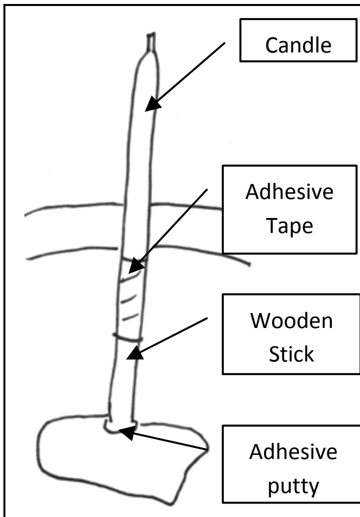
4) Insert the candle into the adhesive putty (or gum or gluestick). The adhesive putty should hold the candle upright. Insure that the bottle can be lowered over the candle. Stick the adhesive putty and the attached candle to the bottom of the basin. Insure that the apparatus is secure.



Step 2: The candle height must be 75% of the bottle height.



Step 3: Use a knife to apply diswashing soap to the candle.

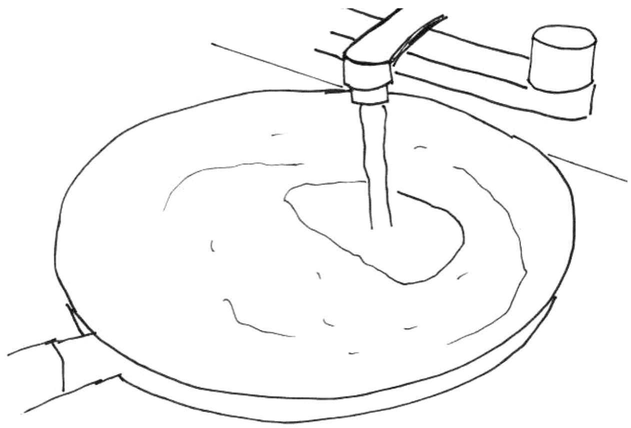


Step 4: Insert the candle into the adhesive putty.

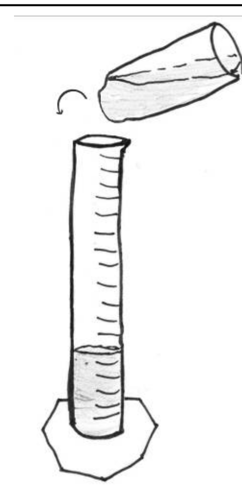
5) Fill the basin with 3-4 cm of water.

DHT Laboratory. "Oxygen Concentrator Measurement." From the publication: Biomedical Technician Assistant (BTA) Skills, Duke University: DHT Lab, 2011.

6) Fill the bottle with water. Measure the bottle volume by pouring this water into a volume measuring device (graduated cylinder, syringe, or measuring cups). Record the ***bottle volume***.



Step 5: Fill the basin with 3-4 cm of water.



Step 6: Fill the bottle with water. Measure the bottle volume.

<u>*Fill the bottle with gas to be measured*</u>
(Find a partner to assist you with the remaining steps. Follow the appropriate steps for filling the bottle with oxygen, room air, or a mixture of both.)

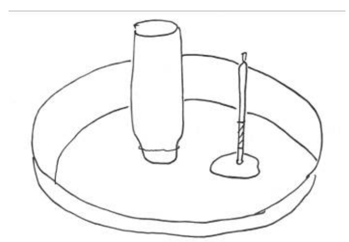
Measuring an oxygen concentrator/cylinder:

7) Fill the bottle completely with water. Cover the bottle mouth with the palm of your hand and turn the bottle upside-down. Keep your hand over the bottle mouth to prevent leakage. Place your hand and the bottle into the water-filled basin. When the mouth of the bottle is underwater, remove your hand. **Insure that water does not leak out of the bottle**. The bottle should now be full of water and upside down.

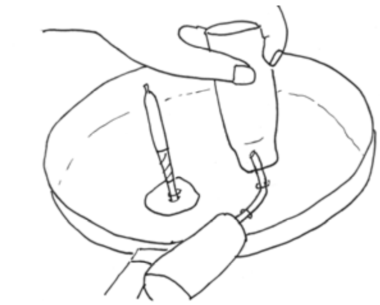
8) Bring the oxygen concentrator close to the basin. Insert the oxygen concentrator tube under the bottle mouth. Turn on the concentrator. The oxygen will displace the water in the bottle. You should see gas bubbles entering the bottle. Fill the entire bottle with gas. The bottle mouth must remain underwater.

9) After the entire bottle is full of gas, remove the tube. Immediately slide the aluminum foil under the bottle mouth. Fasten the aluminum foil around the bottle mouth. Insure that the bottle remains underwater. Do not allow the oxygen to leak out.

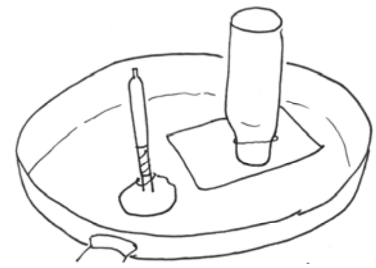
10) Light the candle.



Step: 7Invert the filled bottle into the basin. Insure that water does not leak!



Step 8: Fill the bottle with gas you want to measure.



Step 9: Slide the aluminum foil under the bottle.

Measuring room air:

11) Light the candle.
12) Skip straight to step 16. You will not need the aluminum foil.

Measuring a mix of room air and oxygen:

13) Follow the steps 6, except fill the bottle only partially with water.
14) Follow steps 7 – 9.

Burn away the oxygen

15) Carefully lift the bottle from the water along with the aluminum foil. Let any water on the aluminum foil drip out. Insure that the aluminum foil maintains a tight seal around the mouth of the bottle. **Do not allow the gas inside the bottle to leak out**.

16) Place the bottle above the flame. The bottle should be upside down and the aluminum foil-covered mouth of the bottle should be above the candle flame. **Do not allow the gas inside the bottle to leak out**.

***Note: Be careful in the next step. If you have a high concentration of oxygen, the candle flame will suddenly flare. The flame should be very big. There may be a hissing sound. Do not be frightened. The bottle will not explode.*

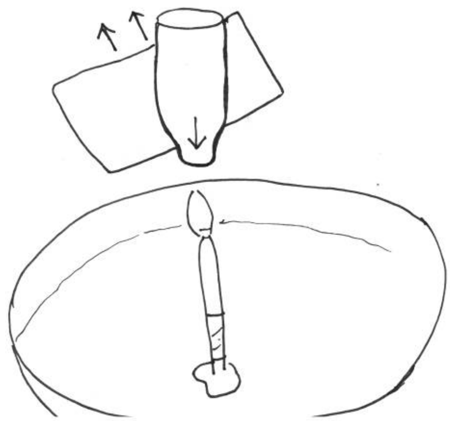
17) In one, quick motion, remove the aluminum foil from the mouth of the bottle and lower the bottle over the lighted candle. Hold the bottle down perpendicular to the basin with the bottle mouth underwater. As the flame burns oxygen, water will enter the bottle from the water basin. Insure that the mouth of the bottle remains underwater.

18) Wait for the flame to die out and let the water level rise in the bottle.
    - If bubbles pop around the bottle mouth, repeat the procedure. Insure that the bottle remains perpendicular to the basin.

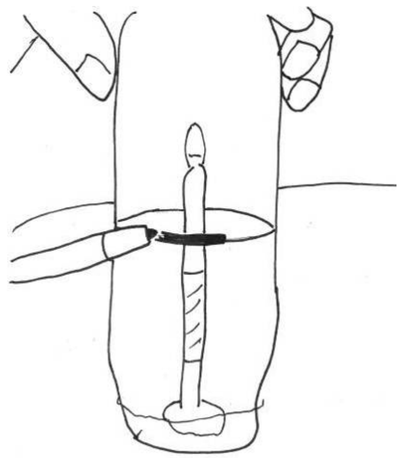
DHT Laboratory. "Oxygen Concentrator Measurement." From the publication: Biomedical Technician Assistant (BTA) Skills, Duke University: DHT Lab, 2011.

- If the water reaches the flame before the flame dies, repeat the procedure. Make sure to re-soap the candle.

19) After the water stops entering the bottle, mark the water level on the bottle.



Step 17: In one quick motion, remove the aluminum foil and lower the bottle over the lighted candle.



Step 19: Mark the water level on the bottle.

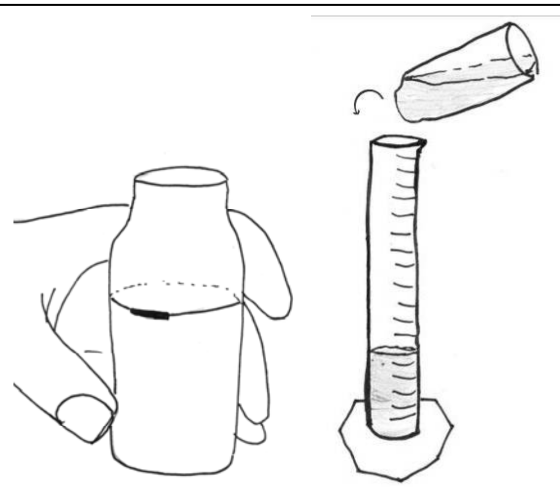
20) Remove the bottle from the basin. Fill the bottle with water to release smoke. Discard the water.

21) Fill the bottle with water up to the mark. Measure the volume of the water in mL. Record this ***measured volume.***

22) Repeat the procedure with a new candle. Record the ***second measured volume***.

23) Average the measured volumes obtained. Record this value as the ***average volume***.

24) Refer to the chart on the following page to determine the oxygen concentration.



Step 21: Fill the bottle up to the mark. Measure this water volume.

Exercise

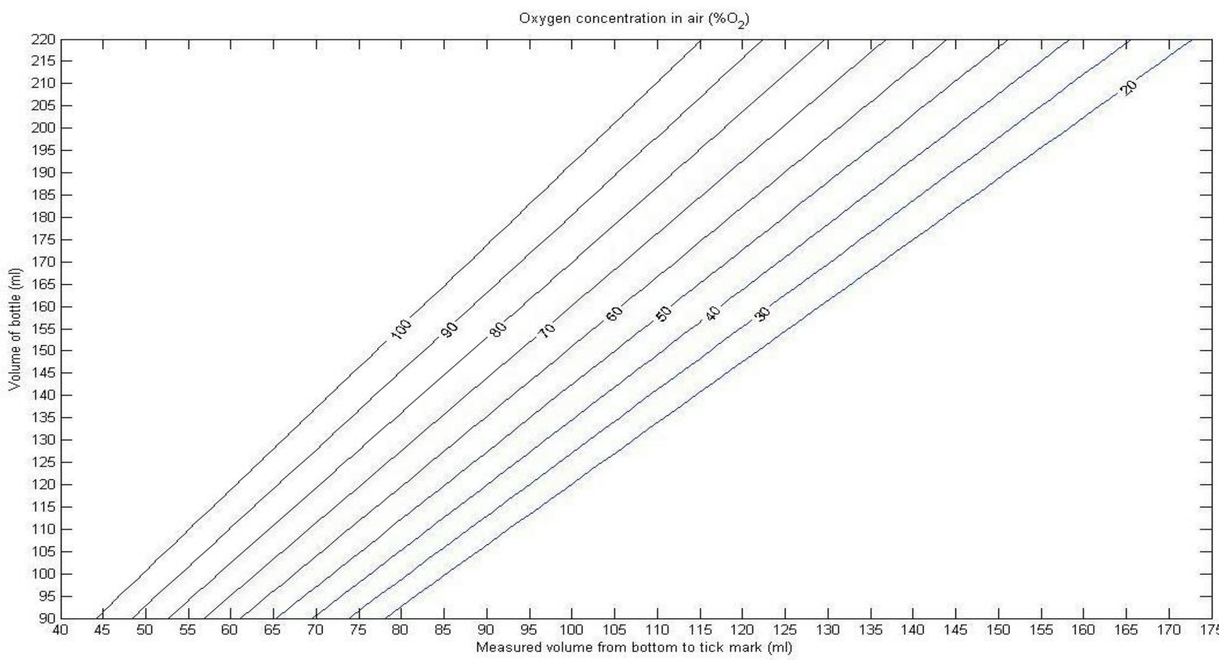
Measure the O_2 concentration with an O_2 cylinder or concentrator, room air, and a mix of the two. Follow steps 1-6 by yourself. Pair up with a partner for the remaining steps. After the first person is finished, the other partner will complete the exercise. Your instructor must verify your work before you continue.

Record your values in the following table:

	O_2 Cylinder / O_2 Concentrator	Room Air	Unknown Concentration
Bottle Volume			
Measured Volume #1			
Measured Volume #2			
Average Volume			
Oxygen Concentration			

To measure oxygen concentration:

1. Locate ***Average measured volume*** on the x-axis
2. Locate ***Bottle volume*** on the y-axis.
3. Locate where these two values intersect on the graph. The line closest to the intersection represents the oxygen concentration (as % O_2 in air).



Preventative Maintenance and Calibration

Insure that there are no cracks or leaks in oxygen concentrators. Check the oxygen level in the oxygen concentrators approximately every six months. Always calibrate every medical device before returning it to use.

DHT Laboratory. "Oxygen Concentrator Measurement." From the publication: Biomedical Technician Assistant (BTA) Skills, Duke University: DHT Lab, 2011.

4. Troubleshooting and Repair of Oxygen Concentrators

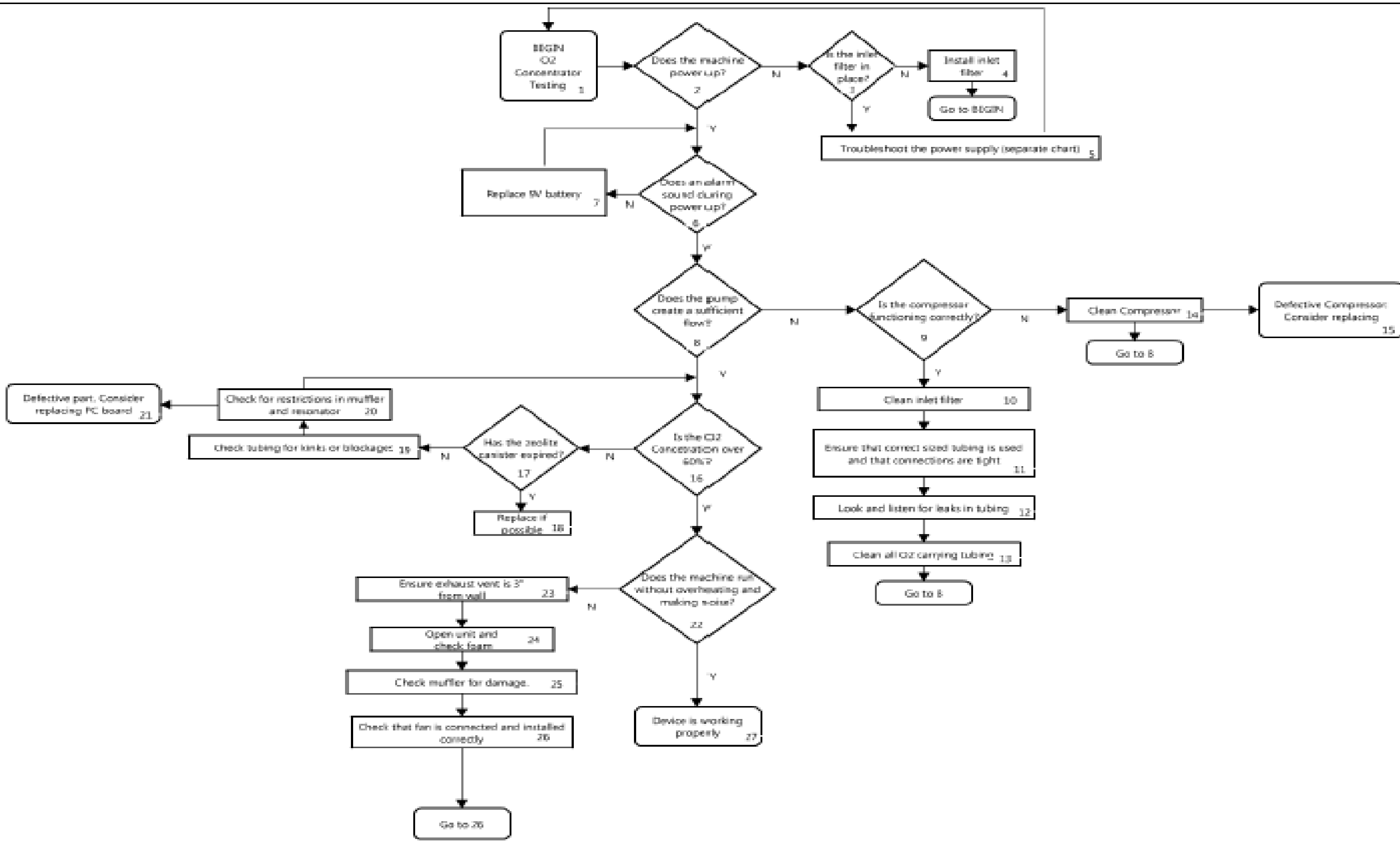
Featured in this Section:

Cooper, Justin and Alex Dahinten for EWH. "Oxygen Concentrator Troubleshooting Flowchart." From the publication: *Medical Equipment Troubleshooting Flowchart Handbook*. Durham, NC: Engineering World Health, 2013.

Strengthening Specialised Clinical Services in the Pacific. *User Care of Medical Equipment: A first line maintenance guide for end users*. (2015).

Oxygen Concentrator Troubleshooting Flowchart

Oxygen Concentrator Repair and Troubleshooting



Cooper, Justin and Alex Dahinten for EWH. "Oxygen Concentrator Troubleshooting Flowchart." From the publication: Medical Equipment Troubleshooting Flowchart Handbook. Durham, NC: Engineering World Health, 2013.

Description

#	Text Box	Explanation
1	Begin O2 Concentrator Testing	Start the diagnostic process for a work order on O2 Concentrator.
2	Does the machine power up?	With unit plugged in, and power switch turned on, the display should light up and compressor should run, making noise.
3	Is the inlet filter in place?	Some models require the compressor inlet filter to be in place in order for machine to start. For all other models, proceed to step 5.
4	Install inlet filter	If available, install the foam inlet filter.
5	Troubleshoot the power supply (separate chart)	Use a multimeter at the leads of the compressor to ensure that sufficient voltage is reaching the machine. If insufficient, there may be a problem with the wiring or fuse. See flowchart on Power Supply and BTA skills on Power Supply.
6	Does the alarm sound during power up?	Both display lights and an audible alarm should sound after power switch is turned on.
7	Replace 9V battery	Unplug machine, ensure current battery has correct polarity, and replace with a new battery if necessary.
8	Does the pump create a sufficient flow?	Flow is identifiable by the floating ball in the flow meter and by bubbles in the humidifier. To check if there is sufficient flow, remove humidifier and place finger at air outlet. When outlet is covered, the ball should fall down. When outlet is unobstructed the ball should float. When flow rate is set to highest setting (5 liters per minute) the ball should be at its highest level in flow meter.
9	Is the compressor functioning correctly?	Check voltage into leads of compressor, and then check flow rate at exit. If the compressor is not producing max flow rate at sufficient voltage (120V), the compressor is not functioning correctly. (Proceed to 13)
10	Clean inlet filter	Foam inlet filter should be cleaned weekly by washing with soap and water. Ensure filter is dry before

		replacing. See BTA skills on Filters (Plumbing)
11	Ensure that correct sized tubing is used and that connections are tight.	Check that the diameter of all O2-carrying tubing matches the machine inlet diameters. Ensure that all connections are tight. Also ensure that the tubing being used cannot diffuse O2. See BTA skills on Connections (Plumbing)
12	Look and listen for leaks in tubing	While air is flowing, listen for sound of escaping O2 and run hand over tubing to feel stream. If holes exist, tube should be replaced, not patched. See BTA skills on Leaking (Plumbing)
13	Clean all O2-carrying tubing	Dirt or water droplets could block the airway. See BTA skills on Blockages (Plumbing)
14	Clean compressor	See BTA skills on cleaning/lubricating (Motors)
15	Defective Compressor: Consider replacing	If compressor is clean, and is still not producing correct flow rate it is probably faulty and needs to be replaced.
16	Is the O2 Concentration over 60%?	See BTA skills for Oxygen Concentration Measurement (Mechanical-Calibration)
17	Has the zeolite canister expired?	Zeolite canisters should be replaced every 25,000 hours. The granules start black and appear gray when they are no longer efficient for use.
18	Replace if possible	If available, replace expired zeolite canisters with new granules.
19	Check tubing for kinks or blockages	Ensure that all O2-carrying tubes are elongated and not twisted or bent. See BTA skills on Blockages (Plumbing)
20	Check for restrictions in muffler and resonator.	A restricted muffler would prevent waste gas from exiting the system freely. Disconnect the muffler and operate unit to see if this fixes concentration.
21	Defective part: Consider replacing PC board.	PC board could have tears or kinks that may be irrecoverable.
22	Does the machine run without overheating and making excessive noise?	The unit should not feel hot to the touch or make loud excessive noises.
23	Ensure exhaust vent is at least 3” from wall.	The exhaust pipe should be far enough away from external obstructions that the waste gas can flow freely into the atmosphere.

24	Open unit and check foam	Foam inside the machine degrades over time and can fall into compressor. Clean and replace foam if possible. See BTA skills on Cleaning (Mechanical)
25	Check muffler for damage	Ensure all tubing to muffler is intact and connected. Check muffler for cracks, damages. Consider replacing if broken.
26	Check that fan is connected and installed correctly	Ensure leads to fan are connected correctly. Check that fan is installed in correct direction of airflow.
27	Device is working properly.	With sufficient air flow and O2 concentration, the machine can be returned to service.

Oxygen Concentrator Troubleshooting Table

Troubleshooting – Oxygen Concentrators

	Fault	Possible Cause	Solution
1.	Unit not operating, power failure alarm sounds	No power from mains socket	Check mains switch is on and cable inserted. Replace fuse with correct voltage / current if blown. Check mains power is present at socket using equipment known to be working. Contact electrician for repair if required.
		Concentrator circuit breaker has been set off.	Press reset button if present
		Electrical cable fault	Try cable on another piece of equipment. Contact electrician for repair if required.
2.	Unit not operating, no power failure alarm	Alarm battery dead	Replace battery (if accessible) and test as above
3.	No oxygen flow	Flow not visible	Place tube under water and look for bubbles. If bubbles emerge steadily, gas is indeed flowing
		Tubes not connected tightly	Check tubing and connectors are fitted tightly
		Water or matter blocking the oxygen tubing	Remove tubing, flush through and dry out before replacing
		Blocked flow meter or humidifier bottle	Replace meter / bottle or refer to biomedical technician
4.	Temperature light or low oxygen alarm is on	Unit overheated or obstructed	Remove any obstruction caused by drapes, bedspread, wall, etc. Clean filters. Turn unit off and use backup oxygen system. Restart unit after 30 minutes. Call biomedical technician if problem not solved.
5	Electrical shocks	Wiring fault	Refer to electrician

Strengthening Specialised Clinical Services in the Pacific. User Care of Medical Equipment: A first line maintenance guide for end users. (2015).

User Care Checklist – Oxygen Concentrators

Daily	
Cleaning	✓ Remove any dust / dirt with damp cloth and dry off ✓ Fill humidifier bottle up to marker with clean distilled water
Visual checks	✓ Check screws, connectors, tubes and parts are tightly fitted
Function checks	✓ Check oxygen flow before clinically required

Weekly	
Cleaning	✓ Wash filter in warm water and dry. Replace if damaged ✓ Clean humidifier bottle thoroughly and dry off ✓ Remove dirt from wheels/any moving part
Visual checks	✓ Replace humidifier bottle if covered with limescale. ✓ If mains plug, cable or socket are damaged, replace
Function checks	✓ Run machine for two minutes and check no alarms occur ✓ Check (see bubbles) that flow rate varies with flow control

Every six months
Biomedical Technician check required

5. Resources for More Information about Oxygen Concentrators

Featured in this Section:

Skeet, Muriel and David Fear. “Oxygen Concentrators.” *Care and Safe Use of Medical Equipment*. VSO Books, 1995.

Wiethöner, F.. “Oxygen Concentrators.” Retrieved From: http://www.frankshospitalworkshop.com/equipment/oxygen_concentrators_equipment.html

Resources for More Information:

Internal Resources at library.ewh.org: For More Information about oxygen concentrators, please see this resource in the BMET Library!

1. Skeet, Muriel and David Fear. "Oxygen Concentrators." *Care and Safe Use of Medical Equipment*. VSO Books, 1995.

External Resources:

1. **Oxygen Concentrator Training Course:**
   - This website provides a short overview of the background of oxygen concentrators, how to use an oxygen concentrator, safety procedures, and oxygen concentrator diagrams. **Wiethöner, F."Oxygen Concentrators." Retrieved From:** http://www.frankshospitalworkshop.com/equipment/oxygen_concentrators_equipment.html

Oxygen Concentrator Bibliography:

Cooper, Justin and Alex Dahinten for EWH. "Oxygen Concentrator Preventative Maintenance." From the publication: *Medical Equipment Troubleshooting Flowchart Handbook*. Durham, NC: Engineering World Health, 2013.

Cooper, Justin and Alex Dahinten for EWH. "Oxygen Concentrator Troubleshooting Flowchart." From the publication: *Medical Equipment Troubleshooting Flowchart Handbook*. Durham, NC: Engineering World Health, 2013

Developing World Healthcare Technology Laboratory. "Oxygen Monitors." From the Publication: "Biomedical Technicians Training Program, Session 3 v2, Special Topics: Cardiac Equipment." *Engineering World Health*, March 1, 2011, p. 115-159.

Developing World Healthcare Technologies Laboratory. "Oxygen Concentrator Measurement." From the publication: Biomedical Technician Assistant (BTA) Skills, Duke University: DHT Lab, 2011.

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Malkin, Robert. "Oxygen Concentrators." *Medical Instrumentation in the Developing World*. Engineering World Health, 2006.

Skeet, Muriel and David Fear. "Oxygen Concentrators." *Care and Safe Use of Medical Equipment*. VSO Books, 1995.

Strengthening Specialised Clinical Services in the Pacific. *User Care of Medical Equipment: A first line maintenance guide for end users*. (2015).

Wiethöner, F."Oxygen Concentrators." Retrieved From: http://www.frankshospitalworkshop.com/equipment/oxygen_concentrators_equipment.html

Wikipedia. "Oxygen Concentrator." *Wikipedia*, p. 1-5. Retrieved from: https://en.wikipedia.org/wiki/Oxygen_concentrator