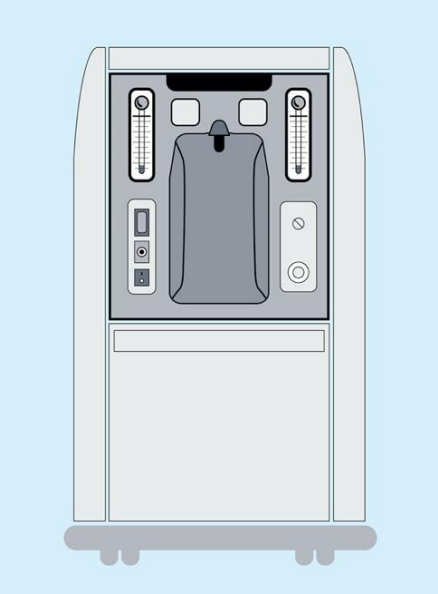
Oxygen Generation and Storage: Oxygen Concentrator

Technical overview

An oxygen concentrator is a medical device that draws in ambient air and passes it through molecular sieve beds to remove nitrogen, thereby concentrating room oxygen to therapeutic levels for safe delivery to patients. Concentrators can provide a sustainable source of medical oxygen across many levels of health systems at facilities that have reliable electricity.



Key specifications

- Oxygen concentrators deliver a continuous flow of oxygen (typically between 90% and 96% concentration) and usually have one built-in-flowmeter (sometimes two) to control the flow of oxygen supplied in liters per minute (LPM). The typical maximum output flow rate ranges from 3 to 12 LPM but can exceed 20 LPM in some units. Oxygen concentrator output pressures range between 30 and 135 kilopascals (kPa). These pressures and flow rates may be insufficient for use with certain equipment, so it is recommended to check the oxygen requirements of accessories to ensure compatibility.
- Audio alarms must be included to alert users of oxygen concentrations below 82%, no flow of oxygen, power supply failure, low battery, overheating, and high or low system pressure. Alarms are also indicators that maintenance is needed.
- Oxygen concentrator manuals must be provided and shall include information on how to troubleshoot common issues with the device.
- The recommended weight of a lightweight oxygen concentrator is less than 27 kilograms.
- Oxygen concentrators should make no more than 50 A-weighted decibels of noise when being used.
- Oxygen concentrators should have a power consumption of less than 70 watts per LPM.

Review the specifications and technical requirements as listed in the *WHO-UNICEF Technical Specifications and Guidance for Oxygen Therapy Devices* for oxygen concentrators as well as the *WHO Technical Specifications for Oxygen Concentrators*.

Regulatory considerations

Oxygen concentrators must be approved by a national regulatory authority of the country of use, and/or any stringent regulatory authority (such as the United States Food and Drug Administration [FDA] or European certification [CE mark]) depending on the country's regulatory requirements. They must also comply with the latest ISO 80601-2-69 or its equivalent.

Infrastructure requirements

To ensure the safety and functionality of an oxygen concentrator, it must have an electrical plug that is compatible with the power outlets of its designated location with an alternating current power format. Furthermore, a concentrator must be configured to match in-country power supply. The two most common configurations are 120 volt (V)/60 hertz (Hz) and 220 V/ 50 Hz. However, there are enough alternate variations that warrant exploration for each procurement.

Back-up power sources, such as generators or uninterruptible power supply, can help provide oxygen during power outages. Power conditioning devices like voltage stabilizers and surge suppressors can help protect the electronics to extend the life of the unit. Oxygen concentrator power requirements can vary from 300 to 600 watts, and these must be accommodated. Deployment of a concentrator will require trained clinical providers and maintenance technicians.

Supply/shipping

The production lead time of oxygen concentrators ranges from 1 to 2 weeks but may take up to 8 weeks or more during high demand. Five to 10 LPM concentrators typically measure 35 to 55 cm wide, 25 to 40 cm deep, and 50 to 70 cm high. They are usually packaged in individual boxes and weigh 15 to 30 kg, with 10 LPM models being heavier and larger than most 5 LPM models. Shipping lead time varies depending on the port of origin and destination, typically between 2 and 12 weeks.

Dependencies for use

To ensure the effectiveness of an oxygen concentrator, it requires a variety of accessories, such as oxygen adaptors, oxygen delivery tubing, an oxygen delivery interface (e.g., nasal prongs, nasal catheter), a flowmeter stand with mounted flowmeters, and a bubble humidifier. An external, hand-held oxygen analyzer must be available for any facility with a concentrator. The cost for an oxygen analyzer might be a deterrent, but they should be made available for all trained technicians.

Maintenance

Maintenance for oxygen concentrators is divided into preventive (scheduled) and corrective:

- Under ***preventive*** maintenance, buyers are recommended to schedule a maintenance appointment with a trained technician at least once per year or every 5,000 operating hours. A trained technician will check oxygen concentration with an oxygen analyzer, check the pressure with a pressure gauge, replace filters as necessary, and check output pressure and flow rate (bubble test). Regular cleaning and decontamination should be performed. Gross particle filters should be removed, washed, and dried weekly or more often in a dusty environment.
- Under ***corrective*** maintenance, buyers will have to adjust or replace device components over time, typically as the result of a device failure or reduction in performance. Commonly replaced components include but are not limited to a compressor, circuit board, internal tubing, sensors, sieve beds, valves, and a ventilation fan.

With proper maintenance and repair, oxygen concentrators can have a lifetime of at least seven years.

Cost

The investment for an oxygen concentrator varies across device models, including the output capacity, manufacturers, and locations. Costs range from US$400 to US$2,000 per concentrator, and approximately US$80 to US$400 for analyzers. Operating costs include electricity, repairs, and maintenance, which will vary by geography, availability of replacement parts, and the on-site technician’s skill levels, respectively. Oxygen concentrators have a minimal cost for initial on-site set-up and installation per unit, but buyers need to consider spare-part supply for maintenance and ongoing power costs.

COVID-19 considerations

In the context of a global pandemic like COVID-19, additional considerations should be raised, including:

- Only concentrators with the requisite pressure specifications can be used to support ventilation. Most ventilators require a 50-psi gas supply, and some have a built-in air compressor. Ensure that concentrators used in combination with mechanical ventilation meet this threshold.
- Due to higher usage during the pandemic, the concentrator's filters should be cleaned more frequently to reduce the risk of contamination.
- Concurrent usage of pulse oximeters is recommended. Other related equipment, such as anesthesia machines, bubble continuous positive airway pressure, and nebulizers, are optional and may require greater pressure than that provided by the available concentrator.
- During the COVID-19 pandemic, production/shipping delays vary by manufacturers.

Acknowledgements

This brief is part of a larger series on technologies and equipment related to ***Oxygen Generation and Storage***. It is intended to serve as a concise primer for decision makers that govern, lead, support, or manage health systems and provide a starting point for understanding the solutions available to meet a health system's need for medical oxygen and its delivery.

This brief series is based on research funded by the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.

The brief series was developed by PATH and Clinton Health Access Initiative (CHAI) as part of the COVID-19 Respiratory Care Response Coordination project—a partnership between PATH, CHAI, and the Every Breath Counts coalition to support country decision-makers in the development and execution of a comprehensive respiratory care plan to meet the demands of COVID-19. The project is also pursuing strategies to help prioritize and improve access to oxygen therapy and other essential equipment involved in respiratory care as an integral part of health systems strengthening, beyond the pandemic response.

The brief series was written by PATH staff Scott Knackstedt, Alex Rothkopf, Stassney Obregon, and Alec Wollen, with support from CHAI staff Jason Houdek, Martha Gartley, and Tayo Olaleye. The authors would like to thank the following individuals for their insightful feedback, including Lisa Smith, Andy Gouws, Evan Spark-DePass, Elena Pantjushenko, Carrie Hemminger, and Conner House.

For more information

path.org/programs/market-dynamics/covid-19-and-oxygen-resource-library

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