THE OXYGEN CONCENTRATOR

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A reliable source of oxygen is essential wherever anaesthetics are administered both to supplement the inspired gas mixture and also for resuscitation. It is traditionally supplied in cylinders which are both bulky and expensive. In isolated areas transportation of cylinders is difficult and may be unreliable, in military situations and disaster areas it may be dangerous or impossible. In many parts of the world the supply of oxygen may fail altogether leaving the anaesthetist with the unenviable task of providing anaesthesia for emergency surgery without access to oxygen, thus putting the patient at considerable risk of hypoxia and death.

Atmospheric air consists of approximately 80% nitrogen and 20% oxygen. An oxygen concentrator uses ambient air as a source of oxygen by separating these two components. It utilises the property of zeolite granules to selectively absorb nitrogen from compressed air.

Atmospheric air is entrained by the concentrator (Fig 1), filtered and raised to a pressure of 20 pounds per square inch (P.S.I.) by a compressor.

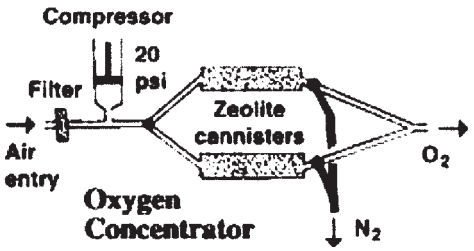


Figure 1.

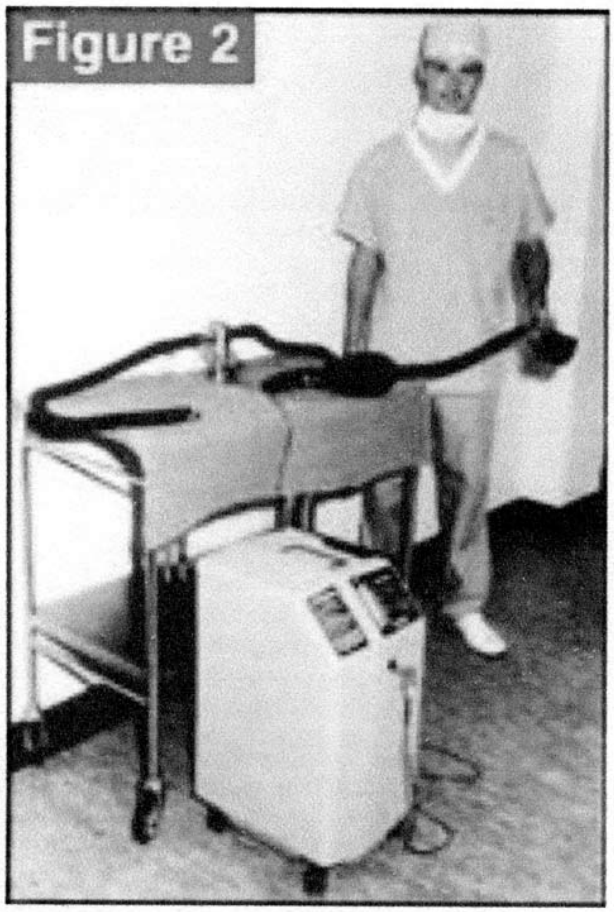
The compressed air is then introduced into one of the canisters containing zeolite granules where nitrogen is selectively absorbed leaving the residual oxygen available for patient use. After about 20 seconds the supply of compressed air is automatically diverted to the second canister where the process is repeated enabling the output of oxygen continue uninterrupted. While the pressure in the second canister is at 20 P.S.I. 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 in the two canisters so that first one and then the other is at 20 P.S.I., a constant supply of oxygen is produced while 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%.

Although this principle has been used on a large scale in units designed to supply entire hospitals with oxygen, interest has recently been focused on smaller units for individual patients. These have already proved their worth for domiciliary use and are now employed with great success in the wards, operating theatres and recovery units of isolated hospitals throughout the world.

The World Health Organisation has introduced minimal safety standards of performance under extreme conditions of temperature, humidity, vibration and atmospheric pollution. Manufacturers have been invited to submit units for testing and so far (September 1991) only the Puritan Bennett model 492A has successfully met all these standards. It is powered electrically from the mains or if this fails a small generator will suffice. The output is continually analysed and the user is alerted by an orange warning light on the front panel if the output concentration falls below 85%. If the oxygen concentrator falls below 70% a red warning light is illuminated indicating malfunction and the unit automatically shuts down. The concentrator is extremely easy to operate, the controls consisting simply of an on/off switch and a flow meter. A pressure alarm sounds when the unit is first turned on and for the next few seconds while the pressure is initially building up to 20 P.S.I. after which the alarm remains silent. It only sounds subsequently if the pressure falls: this usually means the filters need changing. The noise of the compressor is subdued and does not disturb even the most sensitive of surgeons.

Routine maintenance consists merely of changing the filters at regular intervals as directed by the manufacturers and this can be easily achieved using skills available locally. Providing these recommendations are observed the unit requires no other attention and will continue to function for many years.

As the output pressure from the concentrator is low it is not suitable for powering apparatus such as the Manley ventilator or for use with a standard Boyles anaesthetic machine. However it is extremely effective in supplementing air when using a drawover anaesthetic system such as the E.M.0. or Triservice apparatus (see figure 2) or when mechanically ventilating a patient using an electrically powered ventilator such as the East Radcliffe.



In these situations the oxygen is fed via a side-arm into the reservoir tube and the flow rate adjusted to the oxygen concentration required. During anaesthesia with a concentrator flow rate of one litre per minute the inspired oxygen concentration is approximately 35% and with a five litre flow an inspired oxygen concentration greater than 70% can be achieved. It is important that the oxygen is introduced upstream of the vaporizer (see figure 2 Drawover) and not downstream when it will dilute the inspired vapour concentration. It is small and easily transportable and can also be used in the wards and in the recovery room for oxygen therapy and with incubators. A flow splitter is available to allow oxygen to be supplied to up to four separate sites simultaneously if required.

With its record of dependability, ease of maintenance and minimal running costs the initial purchase price of U.S. $2,000 is an excellent investment and will rapidly lead to great savings of money. Even more important it will enable a source of oxygen to be constantly available and reduce anxiety for anaesthetists and risks to patients enabling anaesthesia to be given safely in situations where it might otherwise be extremely hazardous. Ideally no anaesthetist should be placed in a situation where he is expected to provide anaesthesia without access to a reliable source of oxygen. If oxygen is unavailable or supplies are unreliable, the anaesthetist should seek the help of his surgical colleagues and the hospital administrator as a matter of urgency, drawing attention to the advantages of oxygen concentrators.

Further information about the Puritan Bennett model can be obtained from Ian Chapman, Puritan Bennett, Heathrow Causeway, 152-176 Great South West Road, Hounslow, Middlesex TW4 6JS, U.K. Telephone 0181 577 1870.

A nationwide supply of oxygen dependent entirely on concentrators has successfully been set up in Malawi funded by the Danish Aid Organisation DANIDA. Advice on projects of this scale can be obtained from Dr John Pederson, Hostrups Have 5, Idh, DK 1954, Frederiksberg, Denmark. Telephone and fax 45-313 56694.

Information on other makes of oxygen concentrators can be obtained from Dr Michael Dobson, Nuffield Dept of Anaesthesia, John Radcliffe Hospital, Oxford, U.K.