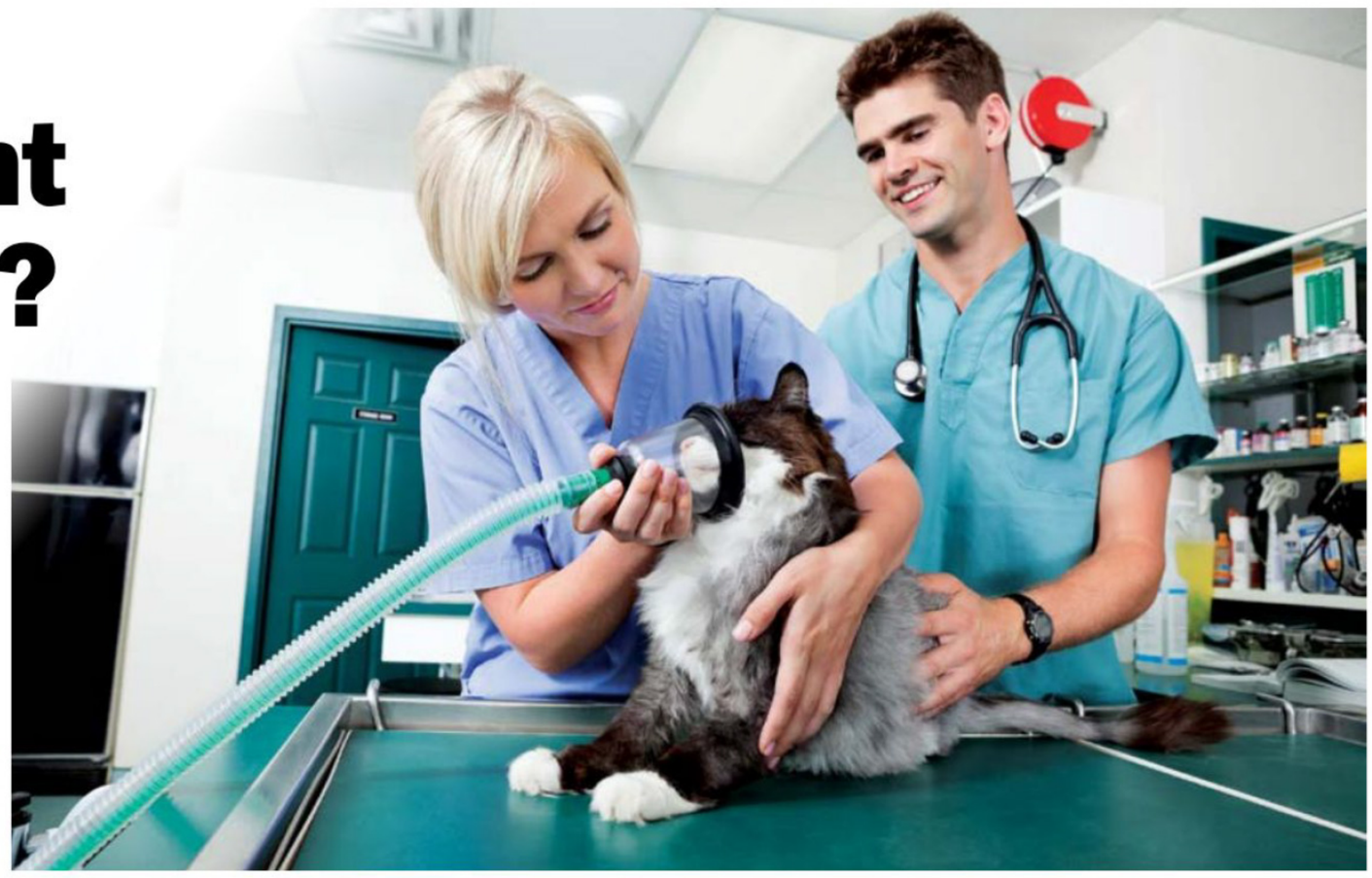
Is an oxygen concentrator right for your practice?



By Frederick B. Morgan

On-site oxygen concentrators (a.k.a. generators) have grown in popularity over the past few years as an attractive and low-cost alternative to using high-pressure oxygen cylinders or liquid oxygen as the primary source of oxygen. With them, veterinary practices can eliminate the expense of purchasing or renting/leasing oxygen cylinders on a monthly basis, along with receiving and monitoring their oxygen supply. The following article provides an overview of oxygen concentrators and offers a few guidelines to consider when purchasing one.

Looking back

Oxygen concentrators were invented in the early 1970s for use in the human home health-care industry for patients with various medical conditions, such as chronic obstructive pulmonary disease (COPD), emphysema, bronchitis, etc. Manufacturing output of these devices increased later that decade. Prior to that, home medical oxygen therapy required the use of heavy high-pressure oxygen cylinders or small cryogenic liquid oxygen systems. In the mid-1980s, Medicare switched to a flat monthly rate for home oxygen, causing the industry to rapidly embrace concentrators as a way to "control costs." Oxygen concentrators became the preferred and most common means of delivering home oxygen. This brief history of oxygen concentrators is important information for the veterinary medical professional, as it closely follows suit with our industry.

How oxygen concentrators work

"Oxygen concentrator" refers to a device that concentrates oxygen from a gas supply (ambient air) by selectively removing nitrogen to provide an oxygen-enriched gas stream. Currently, there are two methods commonly used: pressure swing adsorption (PSA) and vacuum swing adsorption (VSA). Both technologies produce continuous medical-grade oxygen (i.e. United States Pharmacopeia [USP] XXII Oxygen 93 percent Monograph), although oxygen purity for these devices can be as high as 95 percent. A typical PSA system comprises:

- an air compressor;
- a built-in refrigerated air dryer system (as seen in larger systems) to cool and dry ambient air;
- a two-bed oxygen adsorber vessel that separates oxygen in the air from nitrogen; and
- air and oxygen storage/buffer vessels used to stabilize the internal process gas flow, output pounds per square inch (gauge) (PSIG), and overall purity prior to oxygen being delivered to the respective application.

VSA technology (typically seen with larger liter-per-minute-size systems) eliminates many of the design challenges associated with traditional PSA systems. Instead of an oil-injected rotary screw air compressor that is used in a PSA system, VSA technology employs an oil-free "reversible blower," which is ideal and much safer for medical applications.

In addition, as the internal operating pressures are significantly less than PSA, little if any water condensation is formed, so there is no requirement for a refrigerated air dryer system. A single-bed adsorber vessel is used with an oxygen storage/buffer tank setup. Compared to pressure swing adsorption, VSA systems can offer significantly lower operating and preventative maintenance costs during the year and during the lifetime cycle. Lastly, VSA systems typically offer a "smaller" overall size/footprint to accommodate space constraints.

Oxygen concentrators use a molecular sieve material (zeolite) to adsorb gases. They operate on the principle of rapid pressure swing adsorption of atmospheric nitrogen onto zeolite minerals; nitrogen is then vented back into the ambient environment. This process technology is completely regenerative, as the molecular sieve material can last for a significant period. That said, the presence of moisture (water condensate) and/or oil within the process air stream contaminates the molecular sieve and, as a result, this material will need to be replaced. This is why it is extremely important to perform all manufacturer-required preventive maintenance procedures to avoid this situation, along with any additional operating challenges. In summary, molecular sieve material should last at least 10 years in a "normal" operating system/environment.

Choosing the right oxygen concentrator system for your practice

As previously mentioned, oxygen concentrators can be a safe and attractive alternative to using high-pressure oxygen cylinders and/or liquid oxygen. Overall, users can lower their clinic's operating costs as a result of not using equipment subject to price increases, missed deliveries, or being locked into contracts with their oxygen supplier. On the other hand, it is important to note that if an oxygen concentrator system becomes compromised (*e.g.* loss of electrical power), the facility must have a backup oxygen supply available at all times, whether it is a high-pressure oxygen cylinder or liquid oxygen.

To successfully size a precise oxygen concentrator system for your overall requirements, it is recommended you deal with an established and reputable manufacturer. With that said, the following questions regarding existing equipment should be reviewed with the respective manufacturer to address oxygen requirements at your facility:

1) How many anesthesia machines will you be operating at any given time? Each unit requires between 1 to 2 liters per minute (LPM) (oxygen-flow rate).

2) Will you be operating a ventilator in conjunction with an anesthesia machine(s)? Each ventilator requires on average of 4 LPM at 50 psi (output pressure), so it's important to know how many ventilators you'll be using.

3) How many intensive care units and/or oxygen recovery cages will you be operating at any given time? Each unit requires on average upward of 15 LPM to initially "flush" the system and then 5 LPM "to maintain" it. It is critically important to verify with the respective manufacturer/vendor the LPM oxygen-flow rate setting required for this type of equipment.

4) Regarding the first three questions, what is the total number of items/equipment you would be operating simultaneously? By determining this, you will then know the exact liter-per-minute requirement at your facility at a given time.

5) Do you operate any other equipment requiring oxygen (incubators, nebulization, etc.)? Although this would be a relatively small liter-per-minute figure, it is important to know what additional oxygen-flow rate you will need based on the items at your facility requiring oxygen.

6) In addition to excellent ventilation, every oxygen concentrator system requires adequate room/space in which to operate properly. Is this available at your facility? This consideration is sometimes overlooked, and can have a significant effect on the overall performance and longevity of your system. Please note room size is not the underlying issue, but rather the airflow through the room. You need to have enough incoming air to ensure the system is not choked off and have enough outflowing air to ensure the room does not get warmer due to heat from the compressor. Further, care must be given to ensure the space does not become a nitrogen-enriched environment (waste gas).

7) Will you be using a centralized oxygen pipeline/manifold system to deliver oxygen from the oxygen concentrator to all respective equipment? If so, keep in mind you will require a minimum of 20 PSI (output pressure). On the other hand, if you are only using one or two anesthesia machines with a direct connection to these units, a small 10-LPM oxygen concentrator would be adequate. That said, it is recommended the unit also have at least 20 PSI (output pressure). The output pressure is important to operate the flush valve on the anesthesia machine(s).

8) At what elevation (feet or meters above sea level) is your clinic or hospital? An elevation of more than 457 m (1500 ft) above sea level may affect the operation of your system from a flow rate and output pressure standpoint.

Another point to consider is the electrical/voltage requirements for the oxygen concentrator system you are considering buying. The smaller 10-LPM models require only single-phase power; however, larger systems need three-phase power, which may not be available in your location. You should also inquire about start-up and installation procedures for your particular system. Larger systems require professional installation and start-up by the manufacturer.

Future equipment needs

Once you have ascertained the precise oxygen concentrator system for your overall requirements, you should consider what additional equipment (*e.g.* anesthesia machines, ICU/oxygen recovery cage, etc.) you may purchase down the road. Although it is sometimes difficult to determine future needs based on possible facility remodeling/expansion, it is important to keep in mind oxygen concentrator systems can last upward of 15-plus years (on average) depending on their size.

When choosing an oxygen concentrator for your clinic, consider the total number of items/equipment you could be operating simultaneously to ensure you know the exact liter-per-minute requirement at your facility at any given time.

As a result, it is imperative to take this into consideration when sizing your system to ensure you have a liter-per-minute "cushion" available at all times. For example, if you currently require 60 LPM, it is not recommended to purchase a system of that size. In most cases, you may require higher oxygen-flow rates moving forward that your current concentrator system cannot properly handle due to size/volume constraints.

An oxygen concentrator system can be an extremely attractive addition to our clinic/facility, providing a safe and economical alternative. Consult with an accountant/financial advisor regarding tax advantages pertaining to IRS Section 179 and the purchase of capital equipment during the year. ●

Frederick B. Morgan is sales and business development manager, North America, for PCI Gases, a manufacturer since 1984 of medical and industrial vacuum swing adsorption (VSA) oxygen-generating systems located in Riverside, Calif. He has more than 30 years' experience in the air separation industry, with roles in sales and marketing management. Morgan has a bachelor of science from the State University of New York at Buffalo. He can be reached at fmorgan@pcigases.com.