Oxygen concentrators are used for a variety of purposes. This oxygen concentrator FAQ covers medical oxygen concentrators. These units are used in a variety of places such as home use and in hospitals. One particular application for a small portable oxygen concentrator is with U.S. Army Forward Surgical Teams (FSTs). These units travel in Humvees and set up portable hospitals immediately behind active troops in Iraq and Afghanistan. Other uses are for the treatment of sleep apnea and in neonatal units.

Preface
The following information is intended as a simplified overview of the design and operation of personal use oxygen concentrators. It was compiled in response to questions from patients that wanted to know more about the equipment they use.

Oxygen Concentrator Background
The air we breathe is made up of many substances. In a perfect, clean environment (void of smoke, water vapor, etc.) the following is the accepted makeup: (rounded to integer percentages)
- Nitrogen – 78%
- Oxygen – 21%
- Other – 1%

Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tr>
<td>PSA</td>
<td>(Pressure Swing Adsorption) The process used to extract a specific gas from</td>
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<td></td>
<td>a mixture using adsorbent material (such as a Zeolite) using high pressure.</td>
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<tr>
<td>Zeolite</td>
<td>The material used in sieve beds to extract Nitrogen from air as it passes</td>
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<td></td>
<td>through</td>
</tr>
<tr>
<td>Adsorption</td>
<td>Sounds like ‘absorption’ but is very different. Absorption occurs when a</td>
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<tr>
<td></td>
<td>substance combines with another material to change the physical characteristics</td>
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<td>of the host material. (paper towels, Kleenex, toilet tissue all depend on</td>
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<tr>
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<td>absorption). Adsorption occurs when the host material does not change its</td>
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<tr>
<td></td>
<td>characteristics when the added substance adheres to it. The Zeolite material</td>
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<tr>
<td></td>
<td>is a crystalline structure that is quite rigid. Nitrogen molecules chemically</td>
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<tr>
<td></td>
<td>attach to it but do not change its physical structure.</td>
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The Goal of Oxygen Therapy
While the above elements work well for people with normal lung functioning, patients with COPD (and other diseases families) need a stronger concentration of oxygen when they inhale. There are several ways to accomplish this goal:
- High pressure oxygen tanks
- Liquid oxygen
- Oxygen Generators (concentrators)

The first two sources of pure oxygen rely on a regular, steady supply to be delivered to the patient’s home. (except in the case of a home-fill system, discussed in another document)
Only oxygen concentrators have the capability to create the proper amount of oxygen without outside services.

How To Change The Amount of Oxygen In The Air We Breathe
Since normal air contains only 21% oxygen we need to either add or remove something from the air to improve the ability of the patient’s lungs to function. The easiest way is to remove the largest element from the mix. If we remove all of the nitrogen we are left with oxygen and small amounts of other elements (primarily argon, an inert gas).

With nitrogen gone (78% of the air we started with) the percentage of oxygen (which was 21%) and ‘other’ (which was 1%) now become:
- Oxygen – 95%
- ‘Other’ – 5%

Add the original percentages of the two remaining gases (21% + 1% = 22%)
After removing the nitrogen (78%) this 22% become 100% of the result.
Dividing 100% by the original 22% = 4.55
This means every 1% is now equal to 4.55% of the ‘new’ gas.

Oxygen now comprises 95.5% of the ‘new’ gas (21% x 4.55)
‘Other’ now comprises approximately 4.45% of the ‘new’ gas.
For simplicity we accept the percentages to be:
- Oxygen – 95%
How Do Oxygen Concentrators Work?

‘Other’ – 5%
What this is ultimately stating is that the maximum oxygen concentration we can get by removing nitrogen from the air is around 95%. This is important to note when comparing products. None can give more than this percentage but an inefficient design can surely give less.

- How Nitrogen Is Removed From The Air
Many years ago, methods were found that reliably separate specific gas elements. One of these has been adopted for most oxygen concentration systems. PSA (Pressure Swing Adsorption) causes this separation to occur using pressure, as the name implies. Pressure alone doesn’t perform the magic. A special material was also developed to do the hard work. This material is called Zeolite and is actually a microscopic cube with holes on all six sides. Nitrogen molecules chemically bond to its surfaces as they pass through; letting only Oxygen and ‘Other’ elements flow through unimpeded.
The Zeolite is housed in air tight cylinders called ‘sieve beds’. Most oxygen concentrators use two of these ‘beds’ (more on that later).
Of course, once the Zeolite has adsorbed its maximum load of Nitrogen molecules it can’t stop the rest of the Nitrogen from passing through. A process of cleaning out this Nitrogen is referred to as ‘purging’.

- The Oxygen Concentrator
Oxygen Concentrators are made up of the following major components:

<table>
<thead>
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<th>Component</th>
<th>Function</th>
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<tbody>
<tr>
<td>Inlet Air Filter</td>
<td>stops larger particles from entering the system</td>
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<tr>
<td>Compressor*</td>
<td>Pulls in air and pressurizes it to enable the Zeolite to work better</td>
</tr>
<tr>
<td>Sieve Beds</td>
<td>Contain the Zeolite which removes Nitrogen from the air forced into it</td>
</tr>
<tr>
<td>Product (oxygen) Tank</td>
<td>Collects the final product (95% pure oxygen) for delivery to the patient</td>
</tr>
<tr>
<td>Switching Valves</td>
<td>Control the routing of the air through the sieve beds and product tank</td>
</tr>
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</table>

*Note: some people refer to the compressor (inaccurately) as an oxygen concentrator pump.*

The operation of the entire machine is controlled by a microprocessor. The only (normally) operator settable characteristic is [from characteristics are] output flow (settings of 1 through 5 or 6).
Most units include some visual and audible alarms (low oxygen, battery failure, etc.)

- The PSA Process
The following is a simplistic explanation of the Pressure Swing Adsorption [from Adsorption] process used in oxygen concentrators:

1. Room air is pulled in through the inlet filter by the inlet side of the compressor.
2. The air is compressed and forced into sieve bed A (‘charge’ cycle)
3. Oxygen is forced through the sieve bed into the Product Tank
4. After several seconds sieve bed A becomes saturated (full) of Nitrogen
5. The switching valves reroute the gas flow:
   a. Compressed air is now forced into Sieve Bed B
   b. Sieve Bed A inlet (compressor) side is ‘ported’ to atmosphere (the room)
   c. A small amount of pure (95%) oxygen from the product tank flows backward into Sieve Bed A
      i. The combination of pressure drop in Sieve Bed A (we just opened it to atmosphere) and the backflow of pure oxygen cause the Zeolite to release the captured Nitrogen molecules. The Oxygen and Nitrogen remix and enter the room as ‘normal’ air.
6. The air is compressed and forced into sieve bed B (‘charge’ cycle)
7. Oxygen is forced through the sieve bed into the Product Tank
8. After several seconds the cycle repeats with Sieve Bed A

- Conclusion
Oxygen Concentrators are deceptively simple devices in which many elements are in delicate balance. Once this balance is achieved, they are reliable life-saving devices that can be counted on to save and transform lives for the better. To achieve this delicate balance, it is important to work with an experienced development company such as ACS to ensure the highest product quality, economy, and reliability. Contact ACS today at 952-895-1222 to see how we can help make your product concept into reality!