



Push your limit



the
perfect
balance



Altitude Training System

Comparison technologies



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Comparison equipment for altitude training solutions

Training at simulated altitude is comparable to training in the mountains. Mountain air contains less oxygen than air at sea level. At sea level, air contains 20.9% oxygen, and at 2500 meters the oxygen molecules are further apart, with an equivalent of 15.5% oxygen at sea level. This is what we are simulating, by reducing the oxygen content in any closed environment.

b-Cat High Altitude is specialized in building systems that simulate conditions suitable for high altitude training. Worldwide b-Cat has realized many high altitude projects for different purposes such as improving the stamina of athletes and the health of diabetes patients.

The simulated altitude, can be realized in any closed enclosure: from tents, mobile rooms, trucks, mobile houses, or fixed rooms (e.g. bedroom, living areas or training rooms). Depending on where, when and how you wish to apply altitude training, b-Cat can deliver the most suitable solution.

The reduction of the oxygen in the altitude chamber(s) will be established by the aim of a generator which split the surrounding air in the wanted altitude air to the connected Altitude simulation chamber.

What types of generators are available and what are the technical differences ?

We produce in house the next types of generators and we will explain the differences:

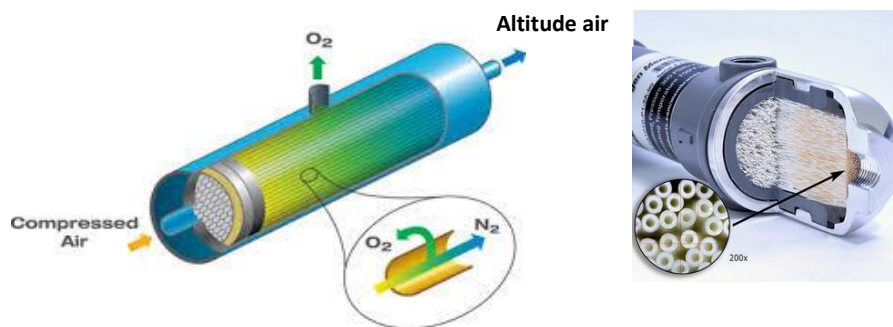
- **Membrane systems**
- **PSA system**
- **VPSA systems**

On the next pages we give you an overview of the differences in technologies.

Membrane system

A 'membrane system' is the most simple type of altitude simulation generator. It is based on the separation of oxygen and other gases from the surrounding air. A membrane system uses one or more permeable hollow fibres to separate the air under a high pressure. This means that the system will need an air screw compressor (8 - 10 bar). A membrane system is the cheapest solution. It consumes high amounts of energy, it has the shortest life span. The generator feed air (compressor) is the most critical part of the of the membrane generator. A properly designed filter arrangement is of utmost importance to prevent contamination of the membranes, with resultant loss of performance over time. The purity of the nitrogen that it produces will decrease in time.

The figure here below gives a clear overview of the working principle of a membrane system



Summery points for the membrane system:

- This is the cheapest system
- On average the smallest system if there is not much space it's to recommend
- The average life span of the membrane is around 4 – 5 years depends also on the service interval of the compressor
- Because of the air – compressor and high pressure we use, the power consumption is high
- The service on the compressor needs to be done by the manufacturer or one of his dealers

PSA technology

PSA (Pressure Swing absorption) technology is fundamentally different from membrane systems. The altitude air is absorbed by activated carbon, a 'sieve', at high pressures, and desorbed or released at low pressures. PSA generators consist of two tanks filled with CMS-f activated carbon. Pressurized air (about 70 psi, 8 bar) is introduced in the first tank, it passes through the sieve, adsorbing oxygen. Just before the first tank becomes completely saturated, feed air is redirected to the second tank, which then repeats the above process. The content of the first tank is then vented into the air, allowing the altitude air to desorb or release from the sieve. To complete the regeneration process of the first tank, a small amount of oxygen is used to purge it. This process is repeated time and time again until the demand is met. Under normal operating conditions, which include the use of clean dry air for separation, the sieve will last for a relatively long time (compared to the membrane system).

Oftentimes, PSA systems should be replaced after 8 - 12 years, sometimes even longer. This has to do with bleeding of oil from the compressor to the active carbon of the PSA. Oil filters should normally avoid oil bleeding, but filter efficiency is never absolute. Maintenance on the compressor and the filter street behind is of highly importance

The picture below gives a clear overview of the working principle of the PSA system.



Summery points for the PSA system:

- Only interesting for big objects > 500 m3 or more;
- PSA is an improvement over the membrane technology.
- PSA technology has a much higher lifespan (8 – 12 years) compared with the membrane technology.
- Because of the air – compressor and high pressure we use, the power consumption is high
- The service on the compressor needs to be done by the manufacturer or one of his dealers

VP SA technology

VP SA technology (Vacuum Pressure Swing Absorption) is based on an energy-efficient, low pressure technique. The oil-free blower ensures that the active carbon is not contaminated by residual oil, resulting in its life-expectancy doubling.

Furthermore, the active carbon filter is cleaned by means of a vacuum technique, allowing it to remain free of dirt and moisture. This makes the VP SA generators from b-Cat the most sustainable and energy-efficient!

With an air pump (also named: low pressure compressor or roots blower) air is sucked on and subsequently blown through one of the containers filled with Activated Carbon. While flowing through the container the air is bound to the activated carbon, remaining the altitude air to leave the container. After a certain period of time all pores of the Activated Carbon are saturated. The Activated Carbon has to be regenerated before it can adsorb once more. The regeneration takes place by means of vacuumizing the containers.

While one container is being regenerated, the other container produces nitrogen and vice versa. Between alternating the processes of adsorption and regeneration a short period of pressure equalization between the two containers takes place. This enables an almost continuous flow of nitrogen.

Summery points for the VP SA system:

- Oil-free pump and a low operation pressure;
- Up to 40% saving of energy compared to PSA- or membrane generators;
- The average life span is around 15 – 20 years, without changing the activated carbon
- About 40% more energy friendly compared to the Membrane and PSA system
- Service can be done by your shelf, and is very simple
- On this system we are able to give > 5 years guarantee on the capacity.



The differences in a table:

	Key technical components	Investment	Energy consumption	Maintenance interval	Average maintenance cost	Noise production range (dB)	Reliability*	Capacity security
Membrane (high pressure)	Compressor + airfilter street+ membrane	Determined by compressor +++	High -	Frequent (high) (Compressor)	High ---	High	Medium ++	1 year ** -
VP SA (Low pressure Activated Carbon)	(oil free) pumps+ Activated Carbon	Favourable for low & medium volumes < 85 m ³ N ₂ /h ¹ ++	Low +++	Less +	Low +++	Medium	High +++	> 8 years +++
PSA (High Pressure Activated Carbon)	Compressor + airfilter street+ Activated Carbon	Favourable for high volumes < 100 m ³ N ₂ /h ¹	Medium +	Frequent (compressor)	Medium -	High	Medium ++	5 years*** +

* the reliability of the high pressure systems mainly depends on the quality of the compressor used

** the airfilterstreet and (part of) membrane tyo be replaced annually

*** 5 years or 40.000 running hoursm, whichever comes first

Other advantages of b-Cat BV

b-Cat holds customer satisfaction as its top priority; it is a policy the company lives by, even after installation of the equipment. B-Cat has a close cooperation with van – Amerongen CA Technology and together we have a service team that is available 24 hours a day in 55 countries in the world. Each machine we recommend to connect to the internet which enables the service team to help the customer with their settings.

We hope with the above standing information we have made clear the differences between the technology we are able to offer for this specific project.

If any additional information is needed, please don't hesitate to contact us.