2 Concentrated Oxygen

Chapter · January 2014

CITATIONS
0

READS
60

1 author:

Rajesh Kumar
Ministry of Science and Technology, India
21 PUBLICATIONS **165** CITATIONS

SEE PROFILE

2 Concentrated Oxygen

Rajesh Kumar

DG' Technical Cell
Council of Scientific and Industrial Research (CSIR)
Department of Scientific and Industrial Research (DSIR)
Anusandhan Bhawan, 2 Rafi Marg, New Delhi- 110 001
Email: <rajesh@csir.res.in>; <rajeshkr38@nic.in>

The environment scientist suggests for proper environmental management to avoid the quarter of all preventable illnesses, which are directly caused by environmental factors. Human being needs air to breathe, water to drink and food to eat but these resources are decreasing due to consumption and increase in population.

The idea of an oxygen bar is not as new as you would perhaps think and it was originally pioneered in Japan towards the end of 1990s. Its popularity soon spread to the United States where they were increasingly found in spas, executive lounges and other recreational businesses. They have even started to appear inside some regular bars. Impressively, in some countries, you can buy recreational oxygen in cans.

The invention extended by creativity and innovation in science spackle some of the miracle and extracted benefit enrich in daily life covering every field, from hygiene food content to tourism at moon and space. The innovative design of household gadget made the common man's life easier. The extended benefits of science create some challenges for scientist, and most concern proven devil is carbon enrich polluted environment due to the industrialization and consumption of fossils fuel. The reducing oxygen content in the atmospheric air, especially in metro cities, is of great concern, and deficiency of oxygen is creating the medical health problems among the living particularly young children. The article explains some benefit of oxygen on the health of common man and the scope of oxygen bar in India prospective *vis-à-vis* challenges.

Almost the entire countries wants a cure for cancer, and it so happens that such a cure naturally exists. Oxygen therapy as the source of cure, there has been widespread opposition and doubt. Once the world comes to accept this cure, humanity will enter a new consciousness of peace and prosperity. However, the oxygen concentrator is an accepted means of delivery of long-term domiciliary oxygen treatment. Conditions of use, however, need to be carefully defined.

The studies conducted in United Kingdom by using fourteen concentrators for one year by patients with hypoxemic chronic obstructive airways disease, and mechanical reliability, patient compliance with a regimen of 15 hours use a day, smoking habits and variation in arterial gas tensions studied. Though many patients failed to achieve either the desired daily use or the recommended arterial oxygen tension, problems were generally minor and could probably be overcome by careful supervision and planning. Overall, the concentrator appeared to be the most economical means of providing oxygen treatment at home and was

much preferred by patients who had previously used oxygen cylinders. The available sources of concentrated oxygen are:

- Cylinders
- Tanks
- Concentrators

An oxygen concentrator, also called an oxygen generator, is a device used to provide oxygen to a person at substantially higher concentrations than those of ambient air, used as an alternative to tanks of compressed oxygen. Oxygen concentrators are also used to provide an economical source of oxygen to the patient/industries.

Portable oxygen concentrators are much easier to set-up than oxygen cylinders. You simply plug the unit into a standard electrical outlet and set the flow meter to your physician's prescribed flow rate. You can easily move from room to room with lightweight portable oxygen concentrators.

Oxygen bar Prospective Scope

The oxygen bars offer sniffers an increased percentage (up to 95%) of oxygen compared to the normal atmospheric content of 21%, as the percentage in Metro cities is lower because of severe pollution. It should be noted that when inhaling normal air (21% oxygen), a healthy human body will, on an average, exhale 14% oxygen, absorbing only 5% of the inhaled oxygen.

Hospitals throughout the developing world have very limited access to oxygen, and when oxygen is available, the equipment required to deliver it is often lacking. WHO/UNICEF has published technical guidelines for oxygen therapy in the management of many diseases in low-income countries, covering the indications for use, sources and equipment for the administration of oxygen.

Health workers did not know when or how to administer oxygen to patient. Most of the concentrators that were available on the pediatric wards were more than 10 years old and did not meet WHO/United

Nations Children's Fund (UNICEF) specifications. It was decided by World Health Organization to supply oxygen concentrators in pediatric wards of all district hospitals and to develop a package of information and tools to cover all stages from procurement, training, installation and maintenance of oxygen concentrators.

Woman inhales concentrated oxygen inside the first oxygen bar in Paris

The oxygen bar concept started in Japan in early 1990, and now, spread over United States, Europe and other countries. The Times of India reported on 19th February 2008, about the opening of oxygen bar in Paris as a late start and writes but Paris first oxygen bar opened only last week. Flagged as *a revolutionary anti-fatigue, anti-stress and anti-depression concept*, the city's maiden oxygen bar is housed in an up-market beauty institute. Indian market has also entered into the business and couple of oxygen bar opened in Delhi, Hyderabad and other cities. The oxygen bar is now concept proven business model concept for health and hygiene spread all over the world and waiting for penetration in Indian market. The globally available oxygen bar is beautifully designed having lots of fun to use. The possible installation destinations for oxygen bars are salons, health clubs and resorts, restaurants, coffee houses, bars and airports. In some countries, caterers are providing oxygen bars for farmhouse for recreation and entertainment. Yoga studios, chiropractors, acupuncturists, medical spas and massage therapists now see how adding an oxygen bar can benefit their clients.

Chemistry of Human body needs Concentrated Oxygen

There are several forms of oxygen, however, the most common and stable form of oxygen is "O_2" or diatomic oxygen. Oxygen is a vital element to good health and it is our primary source of energy. Ninety per cent of our energy comes from oxygen and the other 10% comes from food and water. With oxygen-enriched air (OEA), the body will metabolize food more efficiently, generate more energy and create a healthier body. The conversion process of food into energy is known as oxidation and what is oxidized (or burned) for the body's energy are carbohydrates, sugars, fats and proteins. However, oxygen is the *fuel* required to oxidize all or any of these foodstuffs.

The human body is scientifically works as an *oxygen factory* and the main raw material of the factory is oxygen. Oxygen acts as a fuel, and on consumption of it, cells in our body use to function. Oxygen is the *food* for our cells and body requires enough oxygen around our cells, organs and tissues. The highlighted benefit from using concentrated oxygen, to various function of human body like memory cell improvement and retention, better immune system, sleep disorders digestion problems, better sex, depression headaches

and hangovers, better circulation act as cure for cancer and other disease and burning for calories/fat in human body

One of the matchless ironies of the human body is its requirement for the highly reactive oxygen molecule, which has been clearly implicated in many diseases and the aging rocesses. Oxidants produced by metabolic processes damage cells by starting chemical chain reactions including oxidation of DNA and proteins as well as lipid peroxidation. Damage to DNA can cause mutations and lead to cancer if not reversed by DNA repair mechanisms. Damage to proteins causes enzyme inhibition, denaturation and protein degradation. Lipid peroxidation can cause cell lysis as well as creating mutagenic and carcinogenic byproducts. The human body contains antioxidants and enzymes that together work to prevent oxidative damage to cellular components. Largely antioxidants either prevent these reactive oxygen species from being formed or remove them before they cause damage. There are many theories currently that tout the superior nature of diverse antioxidant combinations. One such theory has been given by Dr. Lester Packer of University of California at Berkley. Dr. Packer puts forth the hypothesis that there is a superlative combination of five antioxidants, which have the ability to *recharge* one another both in the blood plasma and intracellular. This would result in a greater quality of antioxidant protection for an extended time. The current study evaluates Dr. Packer's theory of antioxidant combination from his book *The Antioxidant Miracle*. The decay rate of antioxidants vitamin E, vitamin C, lipoic acid, glutathione and coenzyme Q10 alone and in combination were determined using the oxygen radical absorbance capacity (ORAC) assay. Majority of the antioxidants retained activity for longer periods when tested alone, rather than in combination as Dr. Packer's theory would suggest. The assay was also preformed (using the same antioxidants and combinations) on oxidatively damaged Raji cancer cells. Cell viability and uptake of antioxidants into the cytoplasm were monitored. Finally, a variety of multivitamins was subjected to the ORAC assay and their antioxidant capacity compared to that of the *Packer Combination*. The results suggest that multivitamins are superior antioxidants than the packer ratio listed in the book *The Antioxidant Miracle*.

Oxygen therapy has an incredible healing effect on a wide range of diseases as well as in its ability to rejuvenate the aging body. Oxygen therapy is essential for many functions in our body, especially concerning oxygenating the cells in our body for the health of nervous system and brain. Many cities with high pollution levels have shown an increased cancer rate. The cancer rate in places especially mountain areas where negative ions are emitted was only about 10 to 0% of that in America and Europe, and it was practically non-existent in rural areas of the Himalayas.

Madison Cavanaugh was one of the prominent researchers to investigate that cells are highly oxygenated and the white blood cells destroyed up to three times more microbes than before, after the application of this treatment. Oxygen therapy was found to be beneficial in a wide range of diseases by some health professionals. They found an excellent preventative effect on cancer and cured precancerous conditions such as hyperkeratosis, leukoplasia and chronic mastitis. They are surprised by many of these patients experiencing bursts of energy and euphoria. Mountain regions that are rich with negative ions had less cancer and sickness than those who live in urban cities, according to studies. Experts discovered also that if the treatment is applied. They also found that oxygen therapy was effective with bronchitis, asthma, emphysema and pneumonia. Indian scientists demonstrated how the incidences of tumors of the breast, could be reduced from 100% to between 46 and 57% by the application of oxygen therapy, vitamin C, vitamin A, or selenium. Tumor incidences were further reduced to between 25.9 and 31.8%, in combination of two, and finally, tumor incidence was reduced to only 12%, when all four nutrients were given.

Scientific Principle

Oxygen evolution is the process of generating molecular oxygen through chemical reaction by the process of the photolysis of water during oxygenic photosynthesis, electrolysis of water into oxygen and hydrogen and electro catalytic oxygen evolution from oxides and oxoacids.

X-ray crystallography studies have recently provided detailed models of structure of the oxygen-evolving complex and its manganese cluster. Based on structural and spectroscopic experiments, oxygen evolution involves a core three + one cluster of three manganese ions and one calcium ion with additional manganese, which are oxidized *via* intermediate states called *S-states*.

Oxygen is produced industrially by fractional distillation of liquefied air, chemical means using zeolite, concentration of oxygen in air, electrolysis of water and other means.

The difficulty of obtaining oxygen for the treatment of diving accident victims in remote areas has been a long-standing problem for the NOAA Diving Program. The normal method for transporting oxygen is in metal high-pressure cylinders. These cannot be carried on airliners and contain insufficient oxygen for long-term on-site treatment of diving accident victims or for evacuation to a treatment facility. Chemical production of oxygen by *oxygen candles* likewise produces insufficient oxygen. Atmospheric oxygen concentrators offer the potential of providing a long duration supply of oxygen in remote areas or aboard ships. These devices concentrate the oxygen in air and provide a constant supply of low-pressure oxygen. They have been successfully used as an oxygen source for the production of diver's oxygen enriched breathing gas. The most appropriate type of concentrator for the purposes addressed here are pressure swing adsorption (PSA) units. These devices selectively remove nitrogen from air and produce a breathing gas mixture containing up to 95% oxygen.

They are currently used as a replacement for high-pressure oxygen cylinders to provide oxygen enriched mixtures in the homes of patients who require additional oxygen. These electrically powered devices provide a continuous slow flow of 95% oxygen. The flow rates and pressure output of current units are insufficient for use with the demand type, or free flow oxygen masks currently used to provide pure oxygen to accident victims. However, calculations show that when used with oxygen conserving delivery systems, they will provide sufficient flows of oxygen for the on-site administration of up to 90% oxygen and for the long duration evacuation of diving accident victims, or other patients in need of augmented oxygen. Recently developed PSA units are small, lightweight and can operate on batteries or 12 volts DC electricity, thus, making them practical for use in the field. When used with the oxygen conserving delivery systems identified below, they provide viable methods of providing oxygen for on-site administration and evacuation. The purpose of this study was to evaluate currently available oxygen concentrators and oxygen delivery systems and to provide recommendations to NOAA on the most efficient and cost effective combinations of the systems.

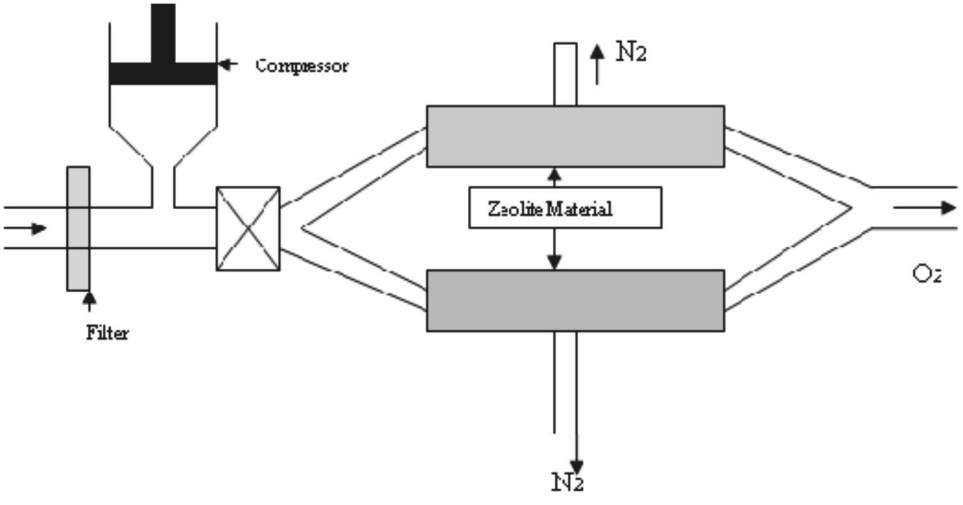
The simplest oxygen concentrator is capable of continuous delivery of oxygen and has internal functions based around two cylinders, filled with a zeolite material, which selectively adsorbs nitrogen in the air. In each cycle, air is flowed through one cylinder at a pressure of air flows through one cylinder at a pressure of around 20 psig, where psig indicates the gauge pressure (138 kPa, or 1.36 atmosphere), where the nitrogen molecules are captured by the zeolite, while the other cylinder is vented off to ambient atmospheric pressure allowing the captured nitrogen to dissipate. Typical units have cycles of around 20 seconds and allow for a continuous supply of oxygen at a flow rate of up to approximately 5 liters per minute (LPM) at concentrations anywhere from 50 to 95%. This process is called pressure swing adsorption (PSA).

Another process has been developed by air products, which they call vacuum swing adsorption (VSA). It uses a single low-pressure blower and a valve, which reverses the flow through the blower so that the regeneration phase occurs under a vacuum. Generators using this process are being marketed to the aquaculture industry enabling the output of oxygen continues uninterrupted. While the pressure in the second canister is at 20 PSI (pounds per square inch), 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 pressure in the two canisters so that first one and then the other is at 20 PSI, a constant supply of oxygen is produced, while the zeolite is continually being regenerated. Individual units have an output of up to 5 liters per minute with an oxygen concentration of up to 95%.

Two oxygen delivery systems were evaluated. The Hi-OX mask is a partial rebreathing open circuit system, and it was selected because of its high efficiency relative to similar simple mask systems. The design of this mask results in the inspiration of high oxygen supply gas during initial portion of the inspiration cycle from a flexible reservoir, and when that is depleted, the latter portion of the inspired gas is made up of surrounding air. The high oxygen mixture, thus, enters the alveoli first, while the air fills the respiratory dead space. This results in higher alveolar oxygen concentrations than it would result if air were mixed with the inspired gas throughout the respiratory cycle.

The closed circuit diving oxygen rebreather, minolung was selected because of its gastight design. Since the gas mixture used contained a minimum of 5% nitrogen rather than pure oxygen, it had to be tested in a semi-closed circuit mode.

The fundamental difference between the above delivery systems is that the resulting alveolar oxygen concentrations at a particular flow/oxygen concentration setting are dependant on the respiratory minute volume, tidal volume and breathing pattern for the HIOX mask, while for the rebreather, alveolar oxygen concentrations depend primarily on oxygen consumption of the individual and are less dependant on breathing pattern and respiratory minute volume.



Oxygen Concentrator

Instrumentation for Oxygen Generation, Storage and Administration of Oxygen

The instrumentation for the design of oxygen concentrator with following objectives:

- To identify the sensor for the oxygen concentrator
- Design and development of oxygen concentrator for biomedical applications
- Characterization of oxygen concentrator on different parameter like temperature, humidity, pressure, flow of gases in the chamber and size and material of sieve for biomedical application.
- Generate objective evidence of the effect of concentrated oxygen produced by oxygen concentrator

The recommended instruments for oxygen concentrator are:

1. Oxygen [O_2] Sensor for measuring the percentage of oxygen in the gas

Single Point Continuous Monitor provides field proven technology for the quick detection of low level gases, the next generation of interface free and low maintenance colourimetric gas detection.

2. A pressure regulator

It is used to control the high pressure of oxygen delivered from a cylinder to a low pressure controllable by the flow meter. The Pressure Sensor Selection Checklist lists the specifications you must consider when choosing a pressure sensor. The most important specifications are electrical output, accuracy, operating environment and mechanical coupling.

The engine test stands used with advanced data-acquisition systems require a different type of pressure sensor than those used in the past. Engine hydraulics and pneumatics operate faster and often with higher pressure and temperature. Accordingly, the pressure sensors have to be more reliable and rugged in order to reduce downtime.

In choosing the correct pressure sensor for your application consider several specifications and decide which type of pressure sensor will give you the best results in your application.

Gage pressure sensors: With gage sensors, pressure readings are referenced to the atmosphere, *i.e.*, zero output is at atmospheric pressure. You use this type of sensor when you need to measure both vacuum (negative output) and pressure (positive output).

Vacuum pressure sensors: A vacuum sensor's output is zero at atmospheric pressure, like the gage sensor but the output increases as the vacuum increases. You calibrate vacuum sensors so their output becomes more positive as the pressure becomes more negative.

Differential Pressure Sensors: This type of sensor has two pressure ports as shown in Figure 1 and senses the difference in pressure between the two ports. You can use differential pressure sensors to measure the pressure of liquids or gasses.

Absolute Pressure Sensors: The reference for this type of sensor is full vacuum, *i.e.*, the output is zero at full vacuum. Note that there is no polarity change when the input pressure changes from vacuum to pressure above atmosphere.

Barometric pressure sensors: Barometric pressure sensors are absolute pressure sensors with a limited range. Usually, the output of these sensors is expressed as *inches of Mercury (Hg)*, and the output ranges are 16-32 inches HgA or 26-32 inches Hg with zero output at low number.

3. A flow meter

It is used to control and indicate the flow of oxygen. Typical flow range is 0-15 lpm.

4. Oxygen Temperature sensor

The sensor needs to monitor temperature during the flow in the process of concentration and at the out let available for the use.

5. Humidity Sensor for Air/oxygen

Rapid advancements in semiconductor technology, such as thin film deposition, ion sputtering and ceramic/silicon coatings, have made possible highly accurate humidity sensors with resistance to chemicals and physical contaminants at economical prices. No single sensor, however, can satisfy every application. Resistive, capacitive and thermal conductivity sensing technologies each offer distinct advantages. Resistive sensors are interchangeable, usable for remote locations and cost effective. Capacitive sensors provide wide relative humidity range and condensation tolerance and if laser trimmed are interchangeable. Thermal conductivity sensors perform well in corrosive environments and at high temperature. For most applications, therefore, the environmental conditions dictate the sensor choice.

The most important specifications to keep in mind when selecting a humidity sensor are:

- Accuracy
- Repeatability
- Interchangeability
- Long-term stability
- Ability to recover from condensation
- Resistance to chemical and physical contaminants
- Size
- Packaging
- Cost effectiveness

Additional significant long-term factors are the costs associated with sensor replacement, field and in-house calibrations, and the complexity and reliability of the signal conditioning and data acquisition (DA) circuitry. For all these considerations to make sense, the prospective user needs an understanding of the most widely used types of humidity sensors and the general trend of their expected performance.

Capacitive Humidity Sensors: They consist of a substrate on which a thin film of polymer or metal oxide is deposited between two conductive electrodes. The sensing surface is coated with a porous metal electrode to protect it from contamination and exposure to condensation.

Resistive Humidity Sensors: Resistive humidity sensors measure the change in electrical impedance of a hygroscopic medium such as a conductive polymer, salt, or treated substrate Resistive sensors usually consist of noble metal electrodes deposited on a substrate by either photo-resist techniques or wire-wound electrodes on a plastic or glass cylinder. The substrate is coated with a salt or conductive

polymer. When it is dissolved or suspended in a liquid binder, it functions as a vehicle to coat the sensor evenly.

Thermal Conductivity Humidity Sensors: These sensors measure the absolute humidity by quantifying the difference between the thermal conductivity of dry air and that of air containing water vapour. When air or gas is dry, it has a greater capacity to *sink* heat, as in the example of a desert climate. A desert can extremely be hot in the day, but at night, the temperature rapidly drops due to the dry atmospheric conditions. By comparison, humid climates do not cool down so rapidly at night because heat is retained by water vapours in the atmosphere.

Challenges for Oxygen Bar in Context to Indian Market

As oxygen bars entry begin to India, health authorities are beginning to question the merits or otherwise of sniffing oxygen. Some of the scientist claims for using concentrated oxygen is not practically proven, and study is continued but some claims that oxygen therapy is not only safe though it enhances health and well-being, including strengthening the immune system and enhancing concentration. It has been alleged to alleviate hangovers and helps with migraines but no formal studies have yet confirmed any of these claims. Individual flavoured scents (aromas) add to the experience.

There is no scientific basis for the health claims made for the oxygen bar. The medical professional research work shows that the concentrated oxygen is harmful for individuals with respiratory diseases such as asthma and emphysema. The colouring and flavouring are yet to receive the approval from legal authorities. In addition, concentrated oxygen is a flame accelerant, which should be kept away from cigarettes and other sources of ignition.

In Frenchay Hospital, Bristol, United Kingdom, J.P. Dilworth and others investigated the impact of installation of oxygen concentrator on lifestyle of 30 patients in two health districts using a questionnaire and found marked improvements in general well-being (83% of respondents), breathing (82%), mobility (62%) and sleep pattern (52%). The long-term nature of the aims of treatment was understood by 83% of the respondents and the mean time period the patients used the concentrator was satisfactory. However, 34% of respondents had a concentrator with only one outlet and 70% had the concentrator situated in a commonly used room with the possibility of problems with noise, while 31% of the respondents were still smoking. The recommendations given to the patients for the sitting of concentrator and the number of outlets should be improved. However, the oxygen concentrator was found generally well tolerated, and this refutes criticism that patients may find it restricting.

However, skepticism regarding the effectiveness of oxygen shoots runs high in medical circles. The atmospheric air contains 21% of oxygen, which is enough for a healthy human body, which absorbs only 5% of the inhaled oxygen. Thus, it is unclear whether increasing the oxygen concentration during inhalation will result in any more oxygen being absorbed than is normally absorbed.

■ ■ ■