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Oxygen Concentrator Generator Using PSA

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Abstract: As oxygen is included in list of essential medicines, yet it's not widely available in remote/developing countries which results in the death of patients. The shortage of oxygen occurred during the covid-19 pandemic which resulted in major loss of life. Also use of oxygen has extended from inpatient to outpatient settings for patients with chronic pulmonary diseases and complications of hypoxemia. Also the supply of oxygen in disaster situations and snowbound mountain areas is a complex issue. The reason for lack of oxygen availability has to do with cost and lack of infrastructure to maintain and install oxygen supply. The second issue rises with the supply of oxygen cylinders in disaster or hard to reach areas. This project proposes an alternative device which will process environmental oxygen in compressed form which can be supplied to patient. An oxygen concentrator is a device that takes oxygen from it's surrounding and processes it to make compressed oxygen which can be supplied to the patient in need. Oxygen concentrators are devices which runs on power supply, easy to carry, provides sustainable percentage of oxygen. Oxygen concentrators are highly reliable and costs less.

Keywords: Microcontroller, compressed oxygen, sieves, oxygen concentrator, compressor.

I INTRODUCTION

At pressures exceeding 50 PSI, an oxygen concentrator generator generates pure oxygen at a rate of roughly 95%. The oxygen concentrator generator's viewpoint is excellent, and it operates flawlessly despite oxygen leaks. We have learned so much while working on it. We gained knowledge of the air-separation pipe, humidifier, and pressure regulator. solenoid valve, wire plug for an Arduino kit, a Malc cable, and an adapter.

The pressure swing adsorption system (PSA) powers the oxygen concentrator generator. To provide patients 90–98% pure oxygen, it filters with ambient air. First, we turn on the compressor and attach the inlet pipe to the concentrator. The compressor is then turned on and adjusted at 50 to 140 PSI. We have an intake air regulator valve set at 50 PSI and an exit pressure regulator when ambient air enters the pressure regulator through the compressor. In order to separate gas mixtures, pressure swing adsorption (PSA) has been used, for example, to collect carbon dioxide during the synthesis of ammonia and to purify hydrogen.

Due to its straightforward operation, good performance at ambient temperatures, high regeneration rate, and low energy intensity, PSA is seen as an appealing method in terms of its high cost-effectiveness. By passing a gas mixture through a reactor that contains sorbent, gas molecules may be separated from the gas mixture in the PSA process under high pressure and low temperature. Once the pressure is reduced, the CO2 is fairly easily released from the adsorbent surface because the electrons between the adsorbent and adsorbate are not shared.

II OBJECTIVES

- The primary aim of this Project is to design and prototype a portable and advanced concentrator for hypoxemic children in low- resource setting.
- To develop a device which can increase oxygen concentration in the air.
- Try to minimize the size of an oxygen concentrator to make it more portable.
- To integrate an oxygen sensor to detect the effectiveness of the device.

III LITERATURE REVIEW

Prof. Y. S. Bais [et.al] 01-05-2022 :-

<u>Shrikant Sapkal:</u>

Oxygen concentrators also known as oxygen generators are widely used in medical, health care industry to generate oxygen for patients. Oxygen concentrators were invented in the 1970's and are used for oxygen generation from atmospheric air in a variety of industries ever since.

<u>Trushal Madankar:</u>

We here develop a oxygen concentrator to generate oxygen from atmospheric air using pneumatic supply. Our machine makes use of pneumatic pressure along with zeolite vessels a separate pressure vessel along with pressure sensors, oxygen sensors and leakage sensors to develop this system

<u>Shekhar Nannaware:</u>

We first use atmospheric air through an external compressor to drive air through our system by valves. The valves drive air through zeolite vessels. We here hold the compressed air through the zeolite vessels so the atmospheric N2 goes through a quadruple moment and the oxygen and other gases are lest free to move. Then release the outlet valves of the vessel to drive the oxygen rich air to the second pressure vessel.

<u>Renuka Sonwal:</u>

The separated N2 is then flushed out through other valve. We simultaneously monitor for leakages as high oxygen levels may fuel combustion. On leakage detection we sound a buzzer and auto shutoff the system

<u>Vaibhav Makode:</u>

The oxygen rich air in second pressure vessel is then pushed through to patient on a regulated basis or supplied to the ventilator as required. The pressure sensors and valves work in coordination to Achieve the desired output.

IV PROJECT METHODOLOGY

- **<u>Compressor Selection:</u>** Choose a suitable compressor that can provide the required air flow rate and pressure (Kumar et al., 2017).

- **<u>Adsorbent Selection:</u>** Select a suitable adsorbent material, such as zeolite molecular sieves, that can selectively adsorb nitrogen (Sircar et al., 2003).

- **<u>Adsorption Column Design</u>**: Design the adsorption columns to ensure efficient adsorption and desorption of nitrogen (Liu et al., 2015).

- **<u>Valve Selection:</u>** Choose suitable valves that can withstand the high pressure and flow rates (Zhang et al., 2018).

- **<u>Control System Design:</u>** Design a control system that can regulate the PSA cycle, including the adsorption and desorption phases (Singh et al., 2020).

V ANALYSIS OF SILICA GEL AND ZEOLITE VESSEL

- <u>Synthetic Zeolite Filter Testing:</u>

Oxygen percentage measurement using a synthetic zeolite filter is shown in Figure 6. In this data, it can be seen that the oxidation process runs long enough, taking about 18 hours to obtain maximum oxidation results. The longer the oxygen concentration level increases until 18 hours of oxidation process obtained a concentration of 23.4%

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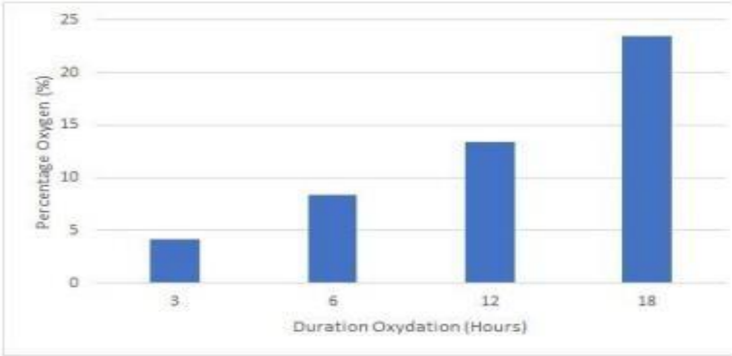

Figure 1: Graph Of Synthetic Zeolit

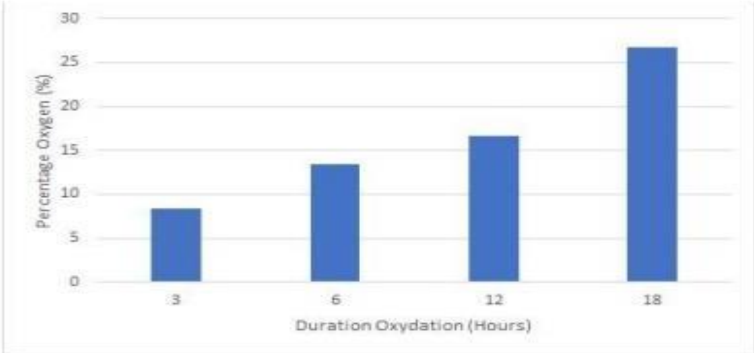

Figure 2: Graph Of Synthetic Silica Gel

VII COMPARISSION OF SILICA GEL & ZEOLITE VESSSEL

1. Silica Gel:

- Oxygen purity: 90-95%
- Oxygen flow rate: 1-5 L/min
- Pressure drop: Moderate

2. Zeolite:

-Oxygen purity: 95-99%
-Oxygen flow rate: 5-10 L/min
- Pressure drop: Low

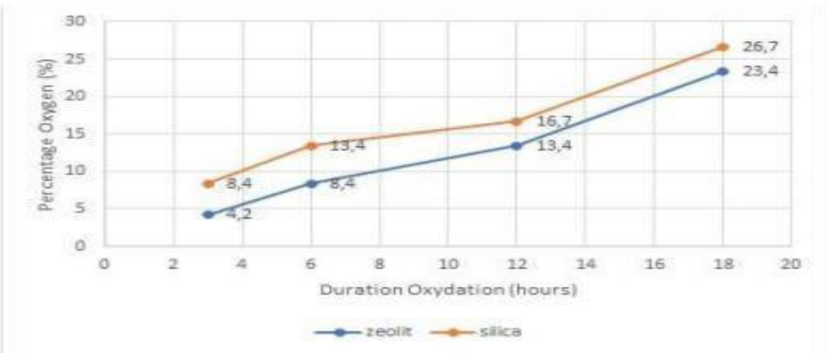

Figure 3: Graph Of Compression Of Silica Gel & Zeolite Vessel

The Fig 3 shows the compression of silica gel and zeolite vessel. The result shows the silica gel is very efficient than zeolite vessel for Ex. the zeolite straps 30% abient air then as compare the zeolite vessel the silica gel can traps the 60-70% abient air from atmosphere

A. GENERAL SPECIFICATION:

1. Oxygen Output: 5-10 liters per minute (adjustable)
2. Oxygen Purity: 93% ± 3%
3. Power Consumption: 200-400 W
4. Dimensions: 24" x 18" x 12" (60 cm x 45 cm x 30 cm)
5. Weight: 50-70 lbs (23-32 kg)

B. TECHNICAL SPECIFICATIN:

1. PSA Technology: Utilizes molecular sieve adsorption
2. Compressor: Oil-free, quiet operation
3. Control System: Microprocessor-based, automatic start/stop
4. Noise Level: <50 dB

VIII BLOCK DIAGRAM

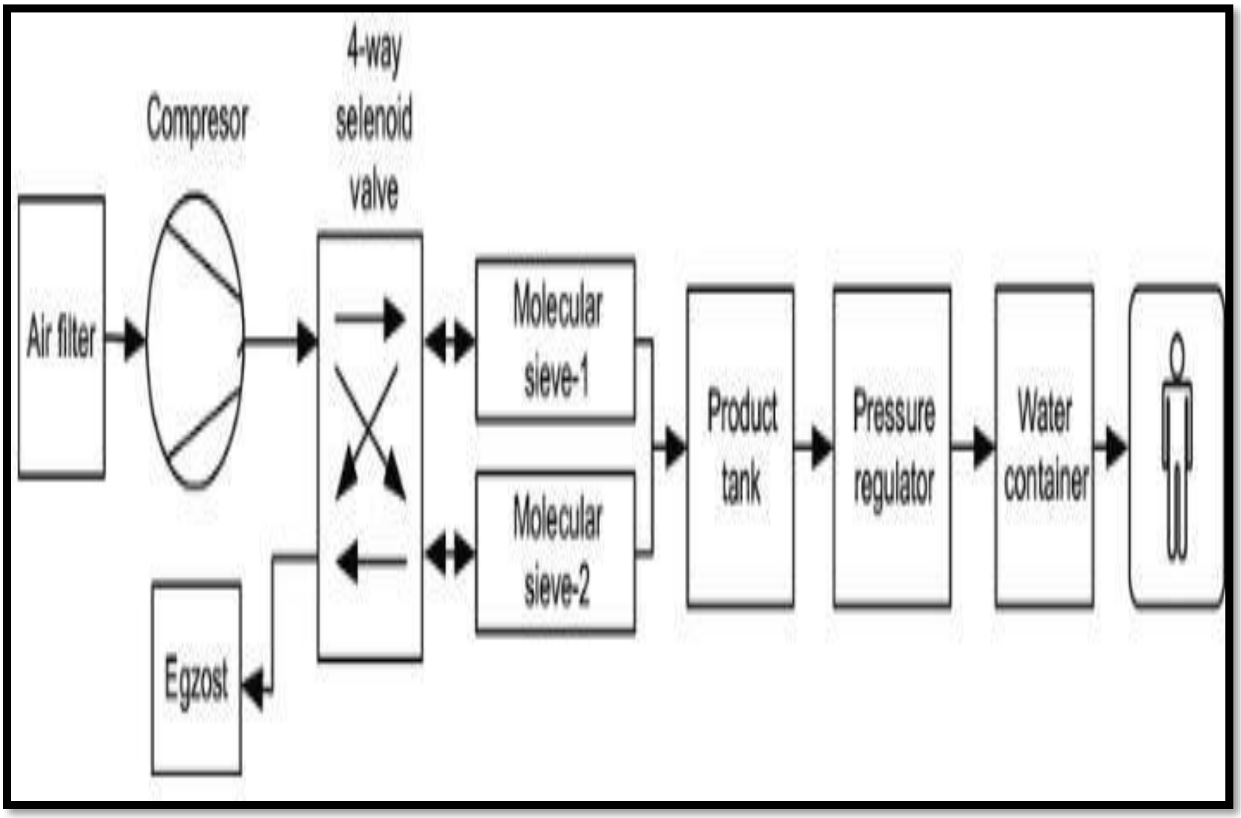

Figure 4: Setup Block Dig

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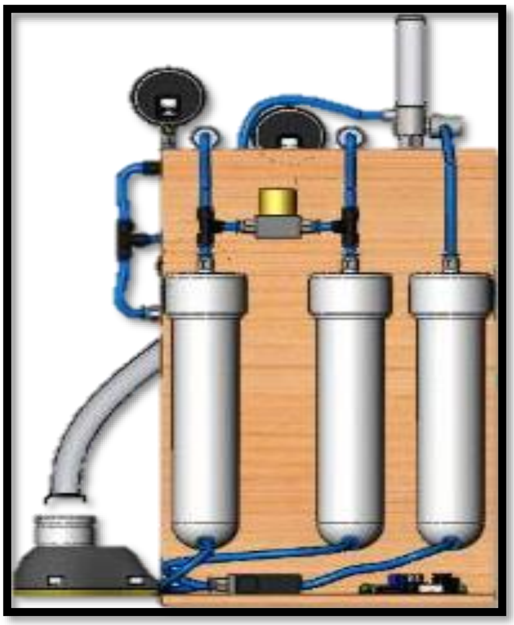
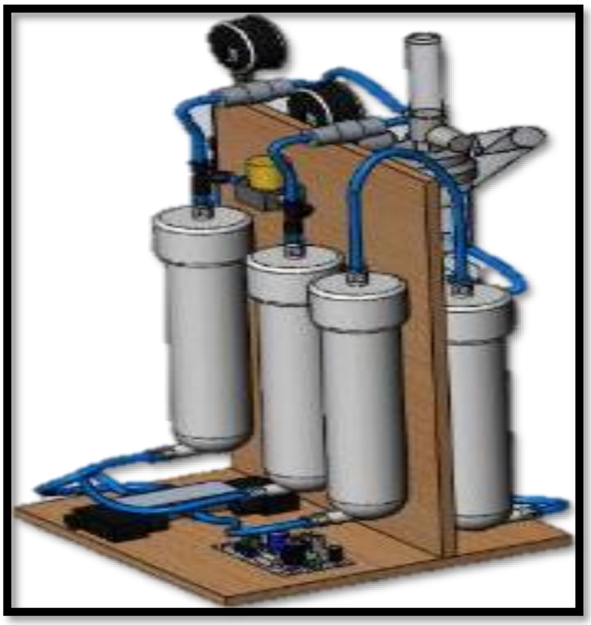
IX CATIA DRAWING





X. WORKING

Oxygen concentrators are devices increasing oxygen in the air to a purity rate of 90% to 97%. The air which we breathe consists of approximately 78% nitrogen, 21% oxygen and 1% other gases. The easiest way to separate the oxygen from the air mixture is to use the pressure swing absorption technology developed by NASA. The process of obtaining oxygen using the pressure swing absorption technology is based on the air being filtered through the aluminosilicate minerals which are known as zeolite. For this purpose, the minerals are placed into a container known as molecular or zeolite bed.

When the ambient air is applied to this structure with a specific pressure, the oxygen passes through it into the output with the applied pressure while the nitrogen molecules in the air are absorbed with the minerals in the bed. Block diagram of the designed oxygen concentrator using the pressure swing absorption technology. The concentrator device consists of an air filter, a compressor, a four-way selenoid valve, a molecular sieve, a product tank, a pressure- regulator, a water container and an exhaust component.

In this system, the air taken from the Oxygen concentrators are devices increasing oxygen in the air to a purity rate of 90% to 97%. The air which we breathe consists of approximately 78% nitrogen, 21% oxygen and 1% other gases. The easiest way to separate the oxygen from the air mixture is to use the pressure swing absorption technology developed by NASA. The process of obtaining oxygen using the pressure swing absorption technology is based on the air being filtered through the aluminosilicate minerals which are known as zeolite.

XI FUTURE SCOPE

1. Increasing demand for oxygen therapy in healthcare.
2. Growing need for oxygen supply in industries (e.g., aerospace, manufacturing)
3. Expanding applications in water treatment, life support systems, and environmental remediation

XII CONCLUSION

- The goal of this project was to examine a pressure swing adsorption process utilizing a adsorbent for the application of oxygen generation and determine the efficiency of the process. As evidenced by the results and discussion chapter, there are numerous ways to operate a PSA process depending on what the process is designed for.

- This leads to the secondary goals of this project, which was to optimize for high recovery of oxygen and for the development of a fast, productive process. It was specifically of interest to investigate the kinetic limit of the adsorbent used. First, based on the ability of the adsorbent used in this process to maintain its efficiency when the feed gas velocity was increased to create 10 second cycles, it can be concluded that this material has a fast adsorption rate.

- All the cycles conducted were of the PSA/VSA hybrid kind. Future work could include a more in depth look at changing the adsorption pressure including operating the cycle as a pure VSA cycle or PSA cycle. Operating at higher adsorption pressures would require larger columns as the effects of the dead volume in the system are magnified at the higher adsorption pressures.

- Operating under VSA conditions would require another pump to pressurize the product gas in order to analyze it. An oxygen concentrator generator using PSA technology is a reliable solution for providing high-concentration oxygen (90-95%) for medical and industrial applications.

- By utilizing a PSA system, these generators can separate oxygen from ambient air, producing a consistent and reliable oxygen supply. The prototype underwent rigorous testing, and the results were promising. The device was able to provide a continuous supply of oxygen at a concentration of 97%, which is more than the minimum requirement for medical oxygen.

- Oxygen concentrators are less dangerous than oxygen cylinders. This makes them particularly advantageous for outdoor use. They are also reliable enough to be provided to patients at home.

- This device does away with the hassle of replenishing cylinders at regular intervals. In this way it helps to control cost of supplying oxygen to patients.

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