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DESIGN AND FABRICATION OF OXYGEN CONCENTRATOR GENERATOR BY USING PRESSURE SWING ABSORPTION SYSTEM (PSA)

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Abstract - Oxygen is used in a variety of chemical processes and for medical purposes throughout the world. Pressure swing adsorption (PSA) has come a doable volition to cryogenic distillation for the separation of oxygen from air with the development of advanced adsorbents like zeolites. PSA processes are constitutionally complex because it's a dynamic process. Effective operation of a PSA process is necessary in order to use the capacity of the adsorbent as much as possible and reduce the power conditions of the process. Medical oxygen concentrators are used for supplying medical grade oxygen to help hypoxemia- related complications related to COVID- 19, habitual obstructive pulmonary complaint (COPD), habitual bronchitis and pneumonia. Medical Oxygen Concentrator constantly use a technology called pressure swing adsorption (PSA), which relies on nitrogen-picky adsorbents for producing oxygen from ambient air. Medical Oxygen Concentrators are constantly designed for fixed product specifications, thereby limiting their use in meeting varying product specifications caused by a change in case's medical condition or exertion. To address this limitation, we design and optimize flexible single- bed MOC systems that are suitable of meeting varying product specification conditions. Specifically, we employ a simulation- predicated optimization frame for optimizing flexible PSA- and pressure vacuum swing adsorption (PVSA)- predicated MOC systems. Detailed optimization studies are performed to standard the performance limits of LiX, LiLSX and 5A zeolite adsorbents. The results indicate that LiLSX outperforms both LiX and 5A, and can produce 90 pure oxygen at21.7 L/min.

Key Words: zeolite; purging; pressure swing adsorption; solenoid valve

1.INTRODUCTION

Oxygen concentrators also known as oxygen creators are extensively used in medical, healthcare assiduity to induce oxygen for cases. Oxygen concentrators were constructed in the 1970's and are used for oxygen generation from atmospheric air in a variety of diligence ever ago. We then develop an oxygen concentrator to induce oxygen from atmospheric air using curvaceous force. Our machine makes use of curvaceous pressure along with zeolite vessels a separate pressure vessel along with pressure detectors, oxygen detectors and leakage detectors to develop this system.

We first use atmospheric air through an external compressor to drive air through our system by faucets. The faucets drive air through zeolite vessels. We then hold the compressed air through the zeolite vessels so the atmospheric N2 goes through a quadruple moment and the oxygen and other feasts are lest free to move. also release the outlet faucets of the vessel to drive the oxygen rich air to the alternate pressure vessel. The separated N2 is also flushed out through another stopcock. We contemporaneously cover for leakages as high oxygen situations may fuel combustion. On leakage discovery we sound a buzzer and bus arrestment the system.

The oxygen rich air in alternate pressure vessel is also pushed through to case on a regulated base or supplied to the ventilator as needed. The pressure detectors and faucets work in collaboration to achieve the asked affair. The pressure and oxygen content of generated air is resemblant displayed on a screen to keep track. The entire system is run by a microcontroller to insure smooth operation.

Still, unlike oxygen cylinders, a concentrator does not bear refilling and can give oxygen 24 hours a day. A typical oxygen concentrator can supply between 5 to 10 liters per nanosecond (LPM) of pure oxygen.

According to pulmonologists, only mild to relatively ill cases with oxygen achromatism situations between 90 to 94 should use an oxygen concentrator under medical guidance. Cases with oxygen achromatism situations as low as 85 can also use oxygen concentrators in exigency situations or till they get sanitarium admission. still, it's recommended that similar cases switch to a cylinder with advanced oxygen inflow and get admitted to a sanitarium as soon as possible. The device isn't judicious for ICU cases.

2. OBJECTIVE

1. The primary aim of this Project is to design and prototype a portable and advanced concentrator for patients with chronic obstructive pulmonary disease (COPD), for chronic hypoxemia and pulmonary oedema.
2. To integrate an oxygen sensor to detect the effectiveness of the device.
3. Try to minimize the size of an oxygen concentrator to make it more portable.
4. To develop a device which can increase oxygen concentration in the air.

3. LITRATURE REVIEW

Kothare, M. V. & Sircar et. al., [1]: - Oxygen concentrators also known as oxygen creators are extensively used in medical, health care assiduity to induce oxygen for cases. Oxygen concentrators were constructed in the 1970's and are used for oxygen generation from atmospheric air in a variety of diligence ever ago.

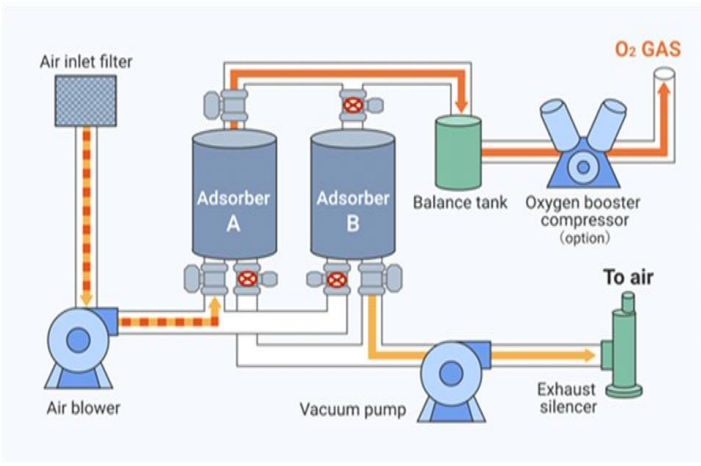
Yang, X. & Liu, W et. al., [3]: - PSA technology is used to separate the admixture of gas species under pressure, according to their molecular structure and the parcels and affinity of the adsorbent. This process works around an ambient range of temperatures. Compared to other styles, PSA is more effective due to controlled temperature. It requires four stages of pressurization, adsorption, blowdown, and purging, as shown in Figure 1. Each stage requires specific pressure to complete the stage, as the incompletion of any stage will affect oxygen product and its chastity position.

Iyer, S. S. & Hasan et. al., [6]: - Zeolites are a group of crystalline accoutrements that are made of unevenly sized pores and a lair system. It's an effective adsorbent for numerous on-volatile(organic) composites since it can repel advanced temperatures and regenerate fully after adsorption.

Y. & Deng et. al., [9]: - A solenoid stopcock is a stopcock that utilizes electromagnetic power to work. A 3/ 2- way NC solenoid stopcock has been used. It has three anchorages and two countries that can be driven electrically and also manually. It has 3 anchorages, bay(P), outlet(A), and exhaust(R). When the force isn't connected also outlet harbourage(A) is connected with exhaust harbourage(R) that's typically unrestricted condition, and when the force of10.8 – 13.2 VDC is handed, it changes its state from typically closed to open condition, hence air moves from bay(P) harbourage to outlet (A) harborage. Use of oxygen-fortified aqueducts produced from air spans from classical chemical engineering to natural and medical operations. There's a significant demand for movable oxygen force for particular use by people demanding oxygen remedy. Medical conditions in humans similar as habitual obstructive pulmonary disease (COPD), limit the capacity of the lung to oxygenate blood by breathing atmospheric air. A constant force of pure oxygen or oxygen- amended air is essential to grease breathing for similar cases.

S. S. & Hasan et.al., [10]: -There are numerous oxygen systems available for cases with habitual conditions similar as habitual obstructive coronary complaint. Oxygen can be stored in tanks and delivered and changed with gas companies for home use. lower tanks can be placed in wagons, which give cases some mobility. Some oxygen concentrators are designed for home use, which are powered using standard wall outlets. There are also POC's designed to be small and featherlight so that cases can carry the device with them in small bags. All of these systems are designed for long term, frequent use.

4. BLOCK DIAGRAM



5. CAD DESIGN (3D)

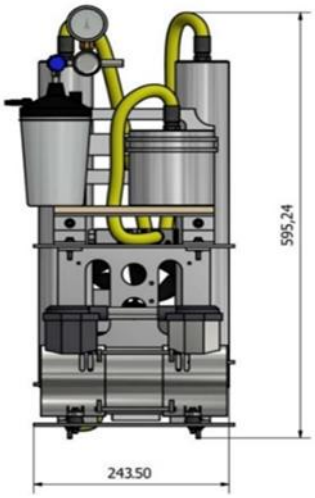


FIG: - FRONT VIEW

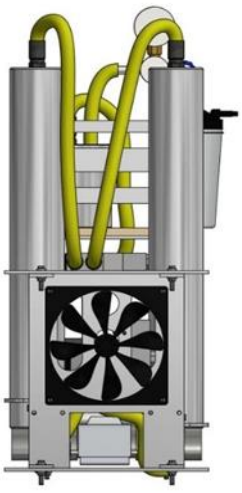


FIG: - REAR VIEW

6. WORKING

Oxygen concentrators are medical bias that help people who have a low position of oxygen in their blood. They're powered by plugging the device into an electrical outlet or by using a battery. However, also it'll need to be charged by plugging it into an electrical outlet, if a battery is used. Utmost concentrators also come with an appendage so you can use the device while you drive. An oxygen concentrator receives air, purifies it, and also distributes the recently formed air. Before it goes into the concentrator, air is made up of 80 percent nitrogen and 20 percent oxygen. An oxygen concentrator uses that air also it comes out as 90 to 95 percent pure oxygen and 5 to 10 percent nitrogen. The nitrogen is separated to give the case the loftiest cure of oxygen possible, as it's delicate to get that chance of oxygen without the help of a medical device.

The 5 Step Concentrator Process

1. Takes air from the room.
2. Compresses the oxygen.
3. Takes out nitrogen from the air.
4. Adjusts the way the air is delivered.
5. Delivers the purified air.

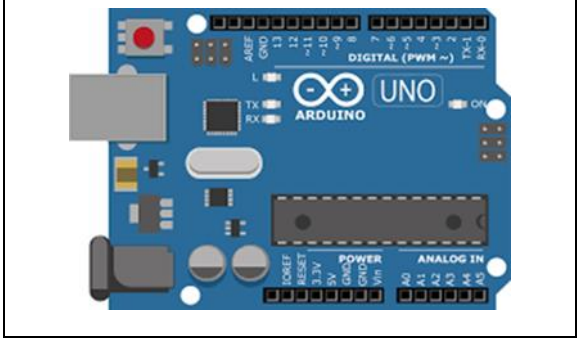
There is numerous corridor that make up a movable oxygen concentrator. A compressor and sieve bed sludge are a couple of the main corridor. The compressor compresses air that's filtered into the concentrator, also delivers the air in a nonstop sluice. The compressed air moves to the sieve bed pollutants. The sieve bed sludge plays an important part, as it's the device that removes the nitrogen from the air. A material called Zeolite, which is a six- sided bits cell with holes on each side, is in the sieve bed and this is what removes the nitrogen from the air. Two sieve beds are located in the concentrator. After air is first compressed in the concentrator, it's forced into the first sieve bed. Oxygen is transferred into the product tank. The first sieve bed also gets filled up with nitrogen. Next, the gas inflow is switched, and the compressed air is moved to the alternate sieve bed. The first sieve bed's compressor is transferred to the outside room, and the air from the product tank goes back into the first sieve bed. The drop in pressure from the first sieve bed and the decaying of oxygen makes the Zeolite release nitrogen. The Oxygen and Nitrogen come back together and are released in the room as regular air. The air is also compressed and transferred to the alternate sieve where Oxygen is moved through it to the Product Tank. The whole cycle starts over again with the first sieve after a many seconds. Other important corridor is the cooling system that keeps the movable oxygen concentrator from overheating, and the nasal cannula that delivers the purified oxygen after the oxygen has been passed through all the sieve bed pollutants. The cannula helps ameliorate oxygen immersion.

7. COMPONENT

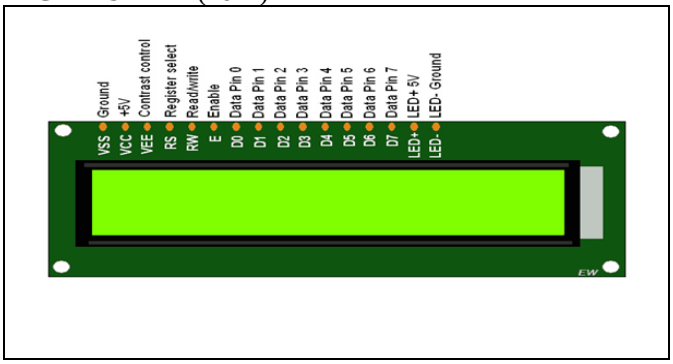
• ESP 8266 Micro-controller	• Capacitor
• Oxygen Sensor	• Transistors
• Pressure sensor	• Cable and Concentrators
• Pneumatic Valve & Joints	• Diodes
• Zeolite Vessel	• PCB and Breadboards
• Pressure Vessel	• LED
• Joints & Fittings	• Transformer/Adaptor
• Supporting Frame	• Push Buttons
• Pneumatic Pipes	• Switch
• Resistors	• IC Sockets

- **SOFTWARE SPECIFICATION**
  - Arduino compiler
  - MC Programming Language
- **COMPONENT SPECIFICATION**

➢ Arduino UNO (12V)



➢ LCD DISPLAY (16*2)



➢ AIR COMPRESSOR

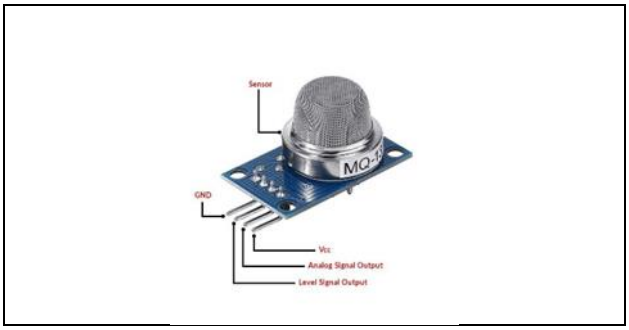
- MEMBRANE HOUSING

- TWO WAY SOLENOID VALVE

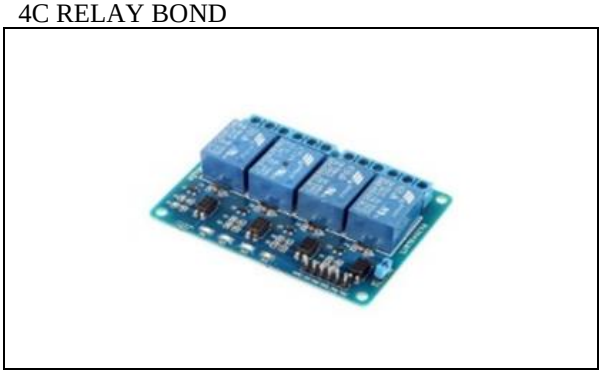
- THREE WAY SOLENOID VALVE

- FLOW SENSOR

- GAS SENSOR



- 4C RELAY BOND



- 12V,5 AMP SMPS

8. ADVANTAGES

- They provide an unlimited supply of oxygen, unlike cylinders, given a consistent power source.
- They do not need to be taken elsewhere to be refilled.
- They are more cost-effective when needed for long-term use than some other methods.
- Whether stationary or portable, they are easier to transport compared to oxygen cylinders.
- They require a one-time installation only.
- While some regular cleaning by the user or caregiver is required, they do not require extensive maintenance.

9. DISADVANTAGES

- Regular use of nasal cannula can result in irritation in the nose.
- It is dependent on power supply at all times, which may be difficult to obtain in remote areas.
- A reserve compressed oxygen tank needs to be kept on hand in case of power failure.
- There is a warm-up period since the machine is turned on until it can be used.
- Filters may need to be changed pretty frequently.
- Some older models make noise and produce a vibration while operating.
- Water vapors in the room can compromise the functioning of the machine over time.

10. APPLICATION

- Oxygen concentrators are used to supply oxygen to patients with chronic obstructive pulmonary disease (COPD), for chronic hypoxemia and pulmonary oedema. They have also been known to be prescribed for the treatment of sleep apnea.
- A portable oxygen concentrator (POC) is a device used to provide oxygen therapy to people that require greater oxygen concentrations than the levels of ambient air. It is similar to a home oxygen concentrator (OC), but is smaller in size and more mobile.
- Medical oxygen concentrators are used in hospitals or at home to concentrate oxygen for patients.
- They are a safer.
- PSA generators are particularly useful in remote or inaccessible parts of the world or mobile medical facilities (military hospitals, disaster facilities).
- More convenient alternative to tanks of cryogenic oxygen or pressurized cylinders. They can be used in various industries including medical, pharmaceutical production, water treatment and glass manufacture.

11. EXPECTED OUTCOMES

- Supplemental oxygen therapy helps people with COPD, COVID-19, emphysema, sleep apnea and other breathing problems get enough oxygen to function and stay well. Low blood oxygen levels (hypoxemia) can damage organs and be life-threatening. You may need oxygen therapy for life or temporarily.
- An oxygen concentrator is a medical device that gives you extra oxygen. Your doctor may prescribe one for you if you have a health condition that causes your oxygen level to drop too low. It can help some people who have trouble breathing due to conditions like: Asthma.
- Oxygen concentrators are used to supply oxygen to patients with chronic obstructive pulmonary disease (COPD), for chronic hypoxemia and pulmonary oedema. They have also been known to be prescribed for the treatment of sleep apnea.
- Safety Tips and Precautions for Portable Oxygen Concentrators. Portable oxygen concentrators (POCs) are safe. However, certain precautions should be taken to ensure continued safety, and if these precautions are adhered to, the use of a portable oxygen concentrator will be safe even when traveling by car or plane.

12. EXPECTED RESULT AND CONCLUSION

- They produce 90–95% oxygen from room air, by absorbing nitrogen. Portable units generally produce 4–10 l/min, and larger devices, producing up to 25 l/min and capable of supplying several an aesthetic machine can also be obtained.
- Oxygen concentrators work the same way as an oxygen cylinder or tank. They suck air from the environment, remove unwanted gases, concentrate oxygen and then blow it through a pipe so that patients can breathe pure oxygen. The advantage here is that concentrators are portable and can work 24x7, unlike oxygen tanks.
- 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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