



Development of Low Cost and Portable Oxygen Concentrator

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ABSTRACT—

An overview of the development of a portable, inexpensive oxygen concentrator. Recently, there has been a lot of attention paid to creating a portable, inexpensive oxygen concentrator, especially in the wake of the COVID19 pandemic. For patients with respiratory disorders that need additional oxygen therapy, such as those with chronic obstructive pulmonary disease (COPD) or pneumonia, this kind of device is made to deliver a consistent source of oxygen. The main problem in building such a system is to make it portable while still delivering a high oxygen concentration and flow rate in a tiny, lightweight package. Innovative technologies like pressure swing adsorption have been used to achieve this. The proposed system also includes a patient health monitoring system that continuously checks a patient's temperature, pulse rate, and blood oxygen levels (SPO2) before sending that information to an IOT cloud where it can be viewed by family members and medical professionals via an Android application. The created IOT monitoring system is ideal for patients who demand the highest level of care because it can also send out an alarm when the patient's body parameters fall below the established threshold.

Keywords—PSA, Oxygen concentrator, Tank, IOT, Portable, SPO2, Pulse, temperature, android etc.

1.INTRODUCTION

Applications for oxygen-enriched air streams range from traditional chemical engineering to biological and medicinal fields. People who require oxygen therapy have a high demand for portable oxygen supplies for personal usage. Human medical diseases like Chronic Obstructive Pulmonary Disease (COPD) restrict the lung's ability to oxygenate blood through atmospheric air inhalation. For such individuals, a steady supply of pure oxygen or air that has been enhanced with oxygen is necessary.

A flexible oxygen supply for individual usage by those who need oxygen treatment is highly desired. Human medical disorders, like diseases like COPD, for instance, greatly impair the capacity of the lung to oxygenate the blood, making the delivery of highly oxygenated air to the lungs that are using external mechanisms absolutely essential. Since it is affordable and environmentally beneficial, the study found that oxygen concentrations of 80% or more may be achieved and maintained with flow rates of 2 to 5 L per min. In order to facilitate oxygen production in remote places, work has been done on an oxygen concentrator based on PSA. On the other hand, PSA units have a key relevance in industrial activities as well. It has four steps of cycle pressurization, adsorption, blow down, purge. Since the failure of any stage will have an impact on the amount and purity of oxygen produced, each stage requires a specified pressure to finish and move on to the following stage of the cycle. Zeolites tend to adsorb twice as much N₂ as O₂.

Due to the widespread use of long-term oxygen therapy (LTOT) and advancements in the monitoring opportunities of treatment, the life quality of patients with chronic obstructive pulmonary disease (COPD) has recently improved while their healthcare costs have also significantly dropped. Utilizing a tiny oxygen cylinder as a breathing device is one alternative for COPD sufferers.

The other alternative is to employ a machine that sucks air in and uses pressure-swing adsorption (PSA) or membrane technology to produce various levels of enriched oxygen, which the COPD sufferers can then use to make breathing easier. These choices have limited portability because of the size and weight of the devices, which limits the movement of these people who could otherwise be more physically active. Therefore, a suitably tiny and lightweight oxygen concentrating device that uses atmospheric air as feed can greatly raise the quality of life for persons who require oxygen therapy to treat lung insufficiency. This project's primary goal is to create a portable, low-cost oxygen concentrator unit using IOT.

2.LITERATURE SURVEY

Since the COVID-19 pandemic, developing low-cost oxygen concentrators has received a lot of attention from researchers and developers. Here is a quick review of the literature on the subject:

- V. K. Gupta , "Development of Low-Cost Oxygen Concentrator for Rural Healthcare in India" (2021): This article discusses the creation of a low-cost oxygen concentrator for use in India's rural healthcare facilities. According to the authors, the machine was able to generate oxygen at a flow rate of 5 litres per minute and a concentration of 93%.
- S. A. Bharath and S. Ganesh Kumar's "Design and Development of Low-Cost Oxygen Concentrator" (2020): In this study, zeolite is used as an adsorbent in a low-cost oxygen concentrator that was designed and developed. According to the authors, the machine was able to generate oxygen at a flow rate of 5 litres per minute and a concentration of 93%.
- S. Kumar . (2020), "Development of a Low-Cost Oxygen Concentrator for Resource-Limited Settings": The creation of a low-cost oxygen concentrator using pressure swing adsorption technology is discussed in this research. The writers reported that device is able to produce oxygen at a concentration of 90-95%.
- N. N. Ram . (2020), "Design and Fabrication of Low Cost Oxygen Concentrator Using Pressure Swing Adsorption Technology": The design and construction of a low-cost oxygen concentrator that makes use of pressure swing adsorption technology are discussed in this study. According to the authors, the machine was able to generate oxygen at a flow rate of 5 litres per minute and a concentration of 93%.

Overall, there has been a lot of research and development done on low-cost oxygen concentrators, and a variety of technologies and methods have been investigated. To increase the effectiveness, dependability, and affordability of these devices, additional research and development are still required.

3. METHODOLOGY

The proposed setup operates on the basis of Pressure swing adsorption, as illustrated in the illustrative diagram. According to their molecular structure, the characteristics of the adsorbent, and pressure, PSA technology is used to separate the mixture of gas species. This procedure operates within the ambient temperature range. Due of the controlled temperature, PSA is more efficient than other techniques. According to the figure, it must go through the four steps of pressurisation, adsorption, blow down, and purging.

Since failure to finish any stage may impair oxygen generation and its purity level, each stage requires a specific pressure to be met in order to be completed. The solenoid valves regulate the flow by controlling the action between the valves. A circuit for pressure equaliser and two three-way valves.

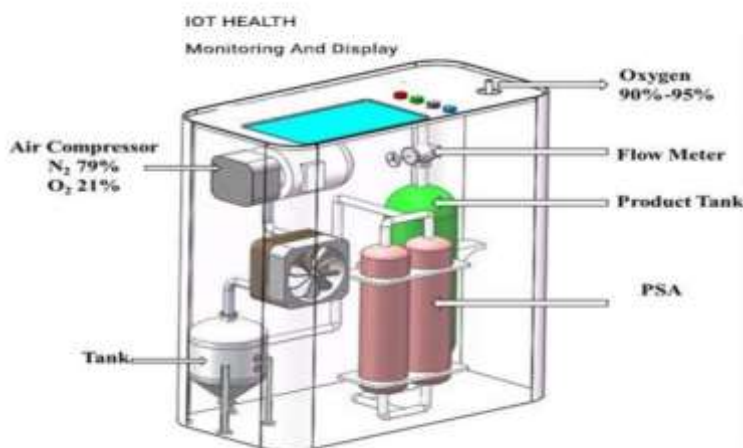


Fig 1 . Expected outcome of the project

A circuit for controlling two 3/2-way valves and pressure equalizer for four cycles of PSA, i.e., pressurization, adsorption, purging, and DE adsorption is made using ESP32 microcontroller and IRFZ44N N-channel MOSFET. IRFZ44N is N-channel type MOSFET.

It is the perfect choice for usage in situations where highspeed switching is a crucial need since it processes highspeed switching capabilities with a very low on-state resistance. The oxygen is stored in the final product tank, which will be used to provide the oxygen outlet based on the requirement, and the flow metre is used to control the flow feedback. The system also has a built-in health monitoring system that will be utilised to track the patient's physiological parameters and provide real-time updates to the doctor utilising IOT and cloud services



Fig 2 . Block diagram of the project

The project's technique is broken down into a number of distinct sections in order to minimise errors at the conclusion. The project will be carried out using the following steps or methodology: literature review, material survey, material choice, creation of a mechanism for adsorbing moisture and compressing air creation of a zeolite chamber for absorbing nitrogen, ESP32 is interfaced with solenoid valves to regulate and oscillate the air's absorption cycles through various sieves to gather oxygen. creation of a mechanism to store oxygen, creation of a mechanism to control oxygen flow, Connecting a pressure sensor to an esp32 to track pressure, as well as connecting a MAX30102 pulse oximeter sensor to track the patient's temperature and SPO2

10. IOT development based system to track patients' health metrics and upload them to the cloud, the creation of an Android application that allows doctors to view patient data in real-time, hardware programming and development, assembling and wrapping up

Hardware used

1. **ESP32 DEVELOPMENT BOARD:** The ESP32 development board is a low-cost, low-power system-on-chip microcontroller circuit board that incorporates WIFI and dual-mode Bluetooth. Its primary usage is to test and develop the ESP32 board's WIFI + Bluetooth functionality.
2. **TRANSISTOR:** A semiconductor device with at least three terminals for connecting to an electronic circuit, often made of semiconductor material. The current flowing through another pair of the transistor's terminals is controlled by the voltage or current provided to one set of those terminals.
3. **OXYGEN FLOW METRE:** Oxygen flow metres typically calculate the amount of gas flowing in litres per minute (Lpm). If an oxygen concentrator or diving tank is being used to monitor the flow, the majority of oxygen flow metres measure between 0 and 15 Lpm. These instruments are made to give a patient who is deficient in oxygen oxygen.
4. **PRESSURE SENSOR:** In accordance with a set of rules, a pressure sensor is a device that can detect a pressure signal and transform it into an electrical signal that can be used as an output.
5. **AIR COMPRESSOR:** An air compressor is a pneumatic tool that transforms power (from an electric motor, diesel engine, or other engine, etc.) into potential energy stored in compressed air under pressure.
6. **FILTER HOUSING:** The filtering box is one of the most crucial components of an oxygen concentrator.
7. **CAN OF OXYGEN STORAGE:** High pressure oxygen tanks, cryogenics, oxygen-rich chemicals and reaction mixtures, and chemical compounds that reversibly release oxygen upon heating or pressure change are just a few of the various ways used to store oxygen for later use. The secondmost significant industrial gas in oxygen.
8. **WIRE MESH:** NiFe alloys with strong ignition resistance, such as Inconel wire mesh, are available. Due to its superior structural matrix and lower ignitability than steel materials, alloy 718 has been utilised extensively in high pressure oxygen units for many years.
9. **HUMIDIFIER:** An oxygen concentrator with a humidifier is a medical tool that facilitates breathing for persons with lung diseases.
10. **MAX30102 PULSE OXYMETER SENSOR:** The MAX30102 sensor is an improved version of the MAX30100 sensor that can be used as both a pulse oximeter and a heart rate monitor.

11. PUSH BUTTONS: They aid in boosting oxygen flow and controlling its flow
12. LCD DISPLAY: It is used to show data and oxygen flow.
13. 6. POWER SUPPLY: An electrical equipment that provides electricity to an electrical load is referred to as a power supply

Software used:

- 1) ARDUINO IDE: Also known as the Arduino Software (IDE), the Arduino Integrated Development Environment (IDE) includes a text editor for writing code, a message box, a text console, a toolbar with buttons for basic operations, and a number of menus. It establishes a connection with the Arduino hardware and communicates with it to upload programmes.
- 2) BRACKETS IDE: A source code editor with a strong emphasis on web development, brackets It was developed by Adobe Inc. and is free and opensource software covered by the MIT Licence. Opensource developers are currently responsible for maintaining it on Github. It is written in HTML, CSS, and Javascript. There is a cross-platform version of brackets
- 3) WAMP SERVER is the third option. With Apache2, PHP, MySQL, and MariaDB, you can build dynamic Web applications using the Windows web development platform WampServer. Everything you require for logically developing Web applications is immediately installed by WampServer. Your server can be tuned without even touching its configuration files.
- 4) ANDROID STUDI: Built on IntelliJ IDEA, Android Studio is the official Integrated Development Environment (IDE) for creating Android apps. In addition to the robust code editor and developer tools provided by IntelliJ, Android Studio provides additional features to increase your efficiency when creating Android apps.

4.CONCLUSION

For the primary care of patients with hypoxemia, the proposed project is anticipated to provide portable oxygen supply equipment. The technology is anticipated to offer a transportable and inexpensive configuration for treating patients with severe hypoxemia as well as resolving the issue of insufficient oxygen delivery during a pandemic. The implementation of the IOT-based health monitoring system is projected to minimize potential delays in the course of therapy by giving the doctor access to real-time patient health analytics. The technology is anticipated to be inexpensive, making it accessible to everyone.

The oxygen concentrator is highly useful in situations similar to COVID. When an emergency like the covid plague is spreading from one person to another, oxygen is urgently needed. Oxygen cylinders were quite useful in this case. The oxygen concentrator was built for a reasonable price and delivers oxygen quickly.

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I want to express my deep gratitude and acknowledgement to the team who created the transportable, affordable oxygen concentrator. Your perseverance and hard work have produced a product that is inexpensive and available to those who require oxygen therapy, particularly at this time of ongoing global pandemic.

Your invention has had an immeasurable impact and helped save many lives by giving patients an alternative to expensive and inconvenient standard oxygen therapy techniques. This technology has revolutionised the healthcare sector thanks to its portability and ease of use, and it has helped many people all over the world live better lives.

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