

“Oxygen Concentrator Generator Using Psa with Leakage Detection for Covid -19”

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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. The project is going to involve a microcontroller which will digitally show the oxygen percentage, oxygen flow, etc. The oxygen is separated through sieves.

This paper presents a prototype to help people with chronic pulmonary diseases and hypoxemia. The project will also help people with supply of oxygen living in remote/developing countries.

Key Words:

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

I. INTRODUCTION

Oxygen concentrators using pressure swing adsorption (PSA) technology are used widely for oxygen provision in healthcare applications, especially where liquid or pressurized oxygen is too dangerous or inconvenient.

An oxygen concentrator is a medical device that provides supplemental or extra oxygen to a patient with breathing issues. The device consists of a compressor, sieve bed filter, oxygen tank, pressure valve, and a nasal cannula (or oxygen mask). Like an oxygen cylinder or tank, a concentrator supplies oxygen to a patient via a mask or nasal tubes.

However, unlike oxygen cylinders, a concentrator doesn't require refilling and can provide oxygen 24 hours a day. A typical oxygen concentrator can supply between 5 to 10 liters per minute (LPM) of pure oxygen.

According to pulmonologists, only mild to moderately ill patients with oxygen saturation levels between 90% to 94% should use an oxygen concentrator under medical guidance. Patients with oxygen saturation levels as low as 85% can also use oxygen concentrators in emergency situations or till they get hospital admission. However, it is recommended that such patients switch to a cylinder with higher oxygen flow and get admitted to a hospital as soon as possible. The device is not advisable for ICU patients.

Oxygen concentrators are the best alternatives to cylinders and liquid medical oxygen, which are comparatively very difficult to store and transport. While concentrators are more expensive than cylinders, they are largely a one-time investment and have low operational costs. Unlike cylinders, concentrators don't require refilling and can keep

producing oxygen 24 hours a day using only ambient air and electricity supply.

II. OBJECTIVE

- 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

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.

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.

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 left free to move. Then release the outlet valves of the vessel to drive the oxygen rich air to the second

pressure vessel. 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.

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. The pressure and oxygen content of generated air is parallel displayed on a screen to keep track. The entire system is run by a microcontroller to ensure smooth operation.

Thus, we successfully develop an oxygen concentrator generator to assist patients in COVID pandemic and other emergency situations.

IV. BLOCK DIAGRAM

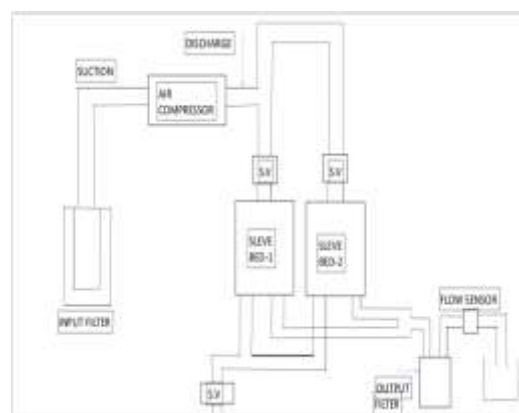


Fig-1: Block diagram

V. CIRCUIT DIAGRAM

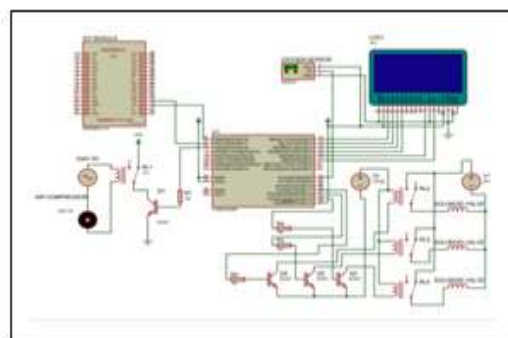


Fig-2: Oxygen concentrator Generator

VI. 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 solenoid 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.

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The Concentrator device consists of an air filter, a compressor, a four-way solenoid 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 atmosphere is passed through the air filter, and then sent to the rest molecular sieve with the pressure provided by compressor. While the pressurized nitrogen which enters into the molecular sieve is being held in the zeolite bed, the oxygen is allowed to pass through unrestricted into the product tank. When the pressure in the product tank reaches 23 PSI, the zeolite in the rest molecular sieve is completely saturated with nitrogen.

Thus, the compressed air is given to the second sieve by changing the valve position so that oxygen production can continue. Meanwhile, the rest molecular sieve is depressurized and regenerated by the removal of the absorbed nitrogen, carbon dioxide and water vapor. When the zeolite in the second sieve is saturated with the nitrogen, the pressurized air is given to the rest sieve again and the nitrogen in the second sieve starts to be thrown out by the egzost system.

The pressurization and depressurization cycle proceeds alternately during the system operation. The oxygen which is brought into a suitable pressure and a purity of 90.95% in the product tank is passed through into the pressure regulator and the oxy-meter respectively. Then, it is given to the patient with a nasal canola or an oxygen mask.

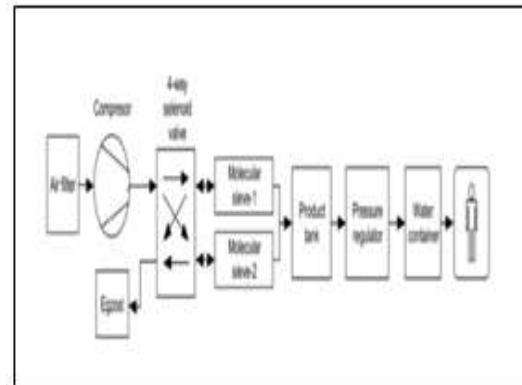


Fig-3: Oxygen concentrator Generator

VII. COMPONENT

1. ESP 8266 Micro-controller
2. Oxygen Sensor
3. Pressure Sensor
4. Pneumatic Pipes
5. Pneumatic Valves & Joints
6. Zeolite Vessel
7. Pressure Vessel
8. Joints & Fittings
9. Supporting Frame
10. Resistors
11. Capacitors
12. Transistors
13. Cables and Connectors
14. Diodes
15. PCB and Breadboards
16. LED
17. Transformer/Adapter
18. Push Buttons
19. Switch
20. IC
21. IC Sockets

7.1 SOFTWARE SPECIFICATION

- Arduino compiler
- MC Programming Language

7.2. COMPONENT SPECIFICATION

- **Arduino Uno(12V)**

Arduino Uno is a micro controller board based on the ATmega328P .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator ,a USB connection, a power jack, an ICSP header and a reset button.

It contains everything needed to support the microcontroller simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.



Fig-4: ArduinoUno

● **LCD display 16*2**

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits.



Fig-5: LCD DISPLAY 16*2

● **AIR COMPRESSOR**

An oxygen concentrator has an air compressor, two cylinders filled with zeolite pellets, a pressure-equalizing reservoir, and some valves and tubes. In the first half-cycle, the first cylinder receives air from the compressor, which lasts about 3 seconds.

ProductDescription Type :Reciprocating Compressor

Application: LBP - Low Back Pressure

ProductDescription: R-134a

Voltage/Frequency: 230V ~ 50Hz

Voltage Range (50 Hz): 160-260

Voltage Range (60 Hz):

LockedRotor Amps (LRA): 8.1

RatedLoadAmps (RLA50 Hz): .8

RatedLoadAmps (RLA60 Hz): 0

Max.Continuous Current (MCCinAmps): 1.28

Motor Resistance (Ohm) - Main: 24.7



Fig-6: AIR COMPRESSOR

● **MEMBRANE HOUSING**

Membrane housing is a pressure vessel for loading membrane elements in a reverse osmosis water treatment system. Currently, there are three types of membrane housings with different materials for water treatment on the market: FRP (fiberglass reinforce plastic), stainless steel and PVC.



Fig-7: Membrane Housing

● **SOLENOID VALVE**

Requires air pressure applied to two different ports in order to move two different directions (such as the case for cylinders lacking a return spring), the solenoid valve supplying air to that actuator must have four ports: one for air supply (P), one forexhaust (E), and two for the cylinder ports (typically labeled A and B).Asco 4-way solenoid valves are generally used to operate double-acting cylinders or actuators.



Fig-8:SOLENOID VALVE

● **FLOW SENSOR**

A flow sensor (more commonly referred to as a “flow meter”) is an electronic device that measures or regulates the flow rate of liquids and gasses within pipes and tubes. Flow sensors are generally connected to gauges to render their measurements, but they can also be connected to computers and digital interfaces.



Fig-9: FLOW SENSOR

● GAS SENSOR

Gas sensors are devices that can detect the presence and concentration of various hazardous gases and vapors, such as toxic or explosive gases, volatile organic compounds (VOCs), humidity, and odors.



Fig-10: GAS SENSOR

● 4C RELAY BORD

The 4 Channel Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontroller such as Arduino, PIC and etc. The relays terminal (COM, NO and NC) is being brought out with screw terminal.

Size (L x W x H): 8 cm x 6 cm x 2 cm



Fig-11: 4C RELAY BOARD

● 12V,5 AMP SMPS

Regulated power supplies have voltage regulators on their output. This means that the regulator ensures the output voltage will always stay at the rated value of the power supply, regardless of the current that the device is consuming.



Fig-12: 12V 5 AMP SMPS

VIII. ADVANTAGES

1. Helpful for asthma patient.
2. Reliable and accurate operation.
3. Maintenance cost is low.
4. Simple In design and also in working.
5. Low cost high efficiency.

IX. DISADVANTAGES

- 1.External power source required
- 2.Noise is one of the common disadvantage
- 3.Regular maintenance
- 4.Maintenance cost required

X. APPLICATIONS

1. Medical oxygen concentrators are used in hospitals or at home to concentrate oxygen for patients.
2. They are a safer.
3. PSA generators are particularly useful in remote or inaccessible parts of the world or mobile medical facilities (military hospitals, disaster facilities).
4. 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.

XI. OUTCOMES

In our project we are introduced a oxygen concentrator generator using psa with leakage detection for covid 19 capable of oxygen generation from free air in atmosphere .The main motive of the project is to hospitals or at home to concentrate oxygen for patients. The multiple function provide in this project. Like IOT mode operation with Wi-Fi connectivity.

The COVID-19 pandemic increased the demand for oxygen concentrators. During the pandemic open source oxygen concentrators were developed, locally manufactured – with prices below imported products – and used, especially during a COVID-19 pandemic wave in India.

XII. RESULT AND CONCLUSION

- 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.

XIII. PROJECT IMAGE

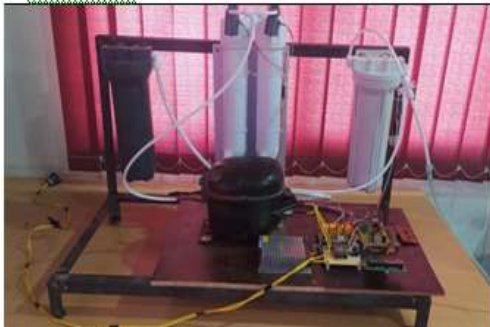


Fig-13: Project assembly

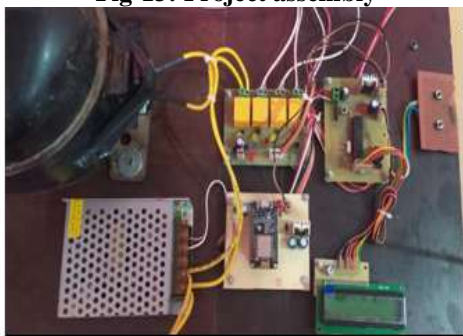


Fig-14: Wiring Diagram

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