DESIGN AND IMPLEMENT AN ARDUINO-BASED OXYGEN CONCENTRATOR USING ARDUINO

Mohamed Majid Abedulhussein*, Nooralhussein Abdalsaleem, Muslim Aqeel Khalaf, Ali Ismael Ali and Noor Bassim Meer

India.

*Corresponding Author

Dr. Mohamed Majid Abedulhussein

India.

ABSTRACT

An oxygen generator is a device that increases the concentration of oxygen gas in the surrounding medium. This device is used in medical fields, where it is used for patients who need oxygen regularly. The use of this device to generate oxygen is one method of oxygen therapy. In this thesis we will design an oxygen concentrator with sufficient capacity using it Arduino. Including providing moral support to the patient. This oxygen concentrator is an assembly made up of a few electronic, mechanical and chemical parts. This is an ArduinoEsp2866 supply circuit, 12V DC p, control relay circuit, solenoid valves, air pressure, filter unit, flow control valve, membrane housing as a box: fittings, and zeolite sieves.

INTRODUCTION

In the world highly affected by pandemic there is a huge spike in covid infection cases With limited resources this fight against Covid 19 virus is an unexpected challenge for the whole world At this condition arranging oxygen cylinders for loved ones is a difficult task Currently relatives have to suffer for cylinder arrangement instead iding moral support to the patient. of pr To get rid of this situation this project is going to be helpful to the society by providing complete details about how to make an oxygen concentrator at home With the help of easily available stuff one can make an oxygen concentrator with enough capacity which can support a covid or any other patient who is in need of oxygen supply There are three methods of providing an oxygen supply in patients: Oxygen concentrators, Oxygen cylinders and Liquid oxygen systems. Oxygen Concentrators run off the home electricity supply. They draw-in air

from the room, separate out the gases with the aid of extracting nitrogen and supply oxygen at the outlet.[1] Standard concentrators can supply to go with the flow charges ranging from 1 to 5 liters per minute. However, professional machines can provide up to 10 liters per minute for excessive demand users, or low float quotes can run at as little as 0.1 liters per minute.[2] They can deliver around 93±3% oxygen when running at a flat rate of up to 4 liters per minute. The share falls with the growing float rate. Portable battery-driven oxygen concentrators generate up to 5 liters of oxygen per minute and can be splendid for ambulatory use.[3 and 4] There are two basic types of oxygen concentrators, stationary and portable. Both of them consist of a cabinet that houses the compressor and filters; tubing; a nasal cannula and/or face mask. Portable units are typically battery operated and lightweight with oxygen output between 1–3 liters per minute (LPM), which is sufficient for one adult. Portable units are generally not considered suitable for clinical settings in low and middle-income countries, as they cannot support multiple patients and are relatively expensive. Stationary units are still portable but are larger and heavier (30–100 pounds) than their portable counterparts and have greater oxygen output capacity (3–12 LPM).[6,7 and 8] A sub-category of stationary concentrators is larger still and capable of output up to 90 LPM. Aims Of study: Design and implement of an oxygen concentrator with sufficient capacity by using Arduino, including providing moral support to the patient. This project will come in handy by posting details on how to make an oxygen concentrator at home. An oxygen concentrator is an assembly made up of a few electronic, mechanical, and chemical parts.

MATERIAL AND METHOD

1- Oxygen concentrator features

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).[9] 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.[10] A typical oxygen concentrator can supply between 5 to 10 liters per minute (LPM) of pure oxygen.

2- Oxygen concentrator device components

Oxygen concentrator is a device that concentrates the oxygen from a gas supply (typically ambient air) by selectively removing nitrogen to supply an oxygen-enriched product gas

stream.[11 and12] They are used industrially and as medical devices for oxygen therapy. Two methods in common use are pressure swing adsorption and membrane gas separation. Pressure swing adsorption (PSA) concentrators utilize multiple molecular sieves consisting of zeolite minerals that adsorbs pressurized nitrogen in fast cycles.[14,15,16 and7]

2.1 Device components

2.1.1 Arduino Esp2866

It is a highly integrated chip designed for network needs. It provides a complete and self-sufficient Wi-Fi network solution, allowing it to either host the app or unload all Wi-Fi functionality from another application processor.[18] The ESP8266 features powerful on-board processing and storage capabilities that allow it to be integrated with sensors and other application-specific devices through its GPIO modules with minimal upfront development and minimal uptime load. ESP8266 NodeMCU Development Panel – is a real delivery and operation solution for inexpensive WiFi projects. The IoT panel has a full ESP8266 WiFi module with each GPIO, a full USB serial interface, and a power source all in one easy-to-use package.[19] 14 This panel was pre-painted with NodeMCU – a Lua-based firmware for ESP8266 that allows easy control via a sleek scripting language Lua.

2-1-2.Power supply

2-1-3. Relay

2-1-4. Zeolite molecular sieves

2-1-5. Air compressor

2-1-6. Filtration unit

2-1-7. Solenoid valve

2-1-8. Pressure Swing Adsorption (PSA)

2-1-9. Espressif Systems' Smart Connectivity Platform (ESCP)

Is a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed WiFi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.[20]
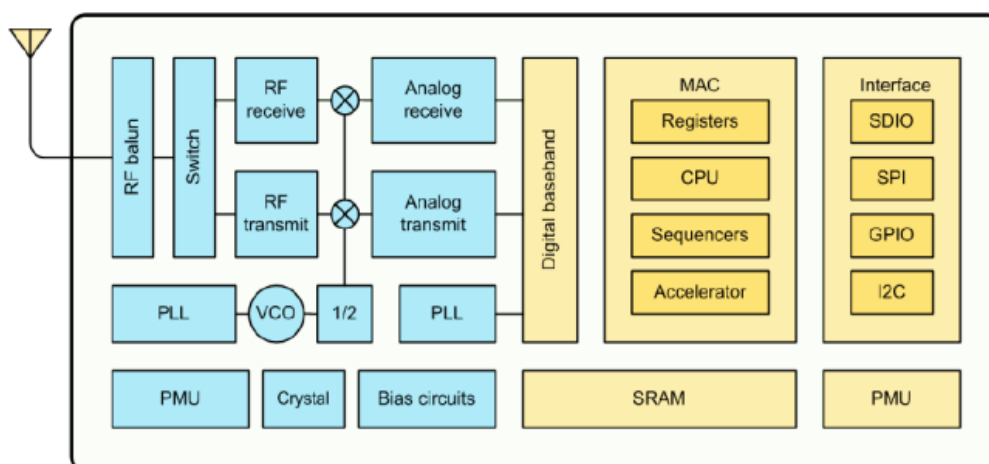
Figure 1.1: Espressif Systems' Smart Connectivity Platform (ESCP).

2-1-10. Software program

RESULT AND DISCUSSION

Designed an oxygen concentrator with sufficient capacity by using Arduino. Including providing moral support to the patient. This Oxygen Concentrator is an assembly made of few electronic, mechanical and chemical parts. Those are Arduino Esp 2866, 12 V DC p supply circuit, Control Relay Circuit, Solenoid Valves, Air Compress, Filtration Unit, Flow Control Valve, Membrane Housing as Canister: Fittings, and Zeolite Sieves. For the generation of oxygen we are using Pressure Swing Adsorption Technique with two Zeolite filters which are semi continuously fed with pressurised air feed with help of 5 ports 2 way operated Direction Control Valve (5 ports::1 inlet, 2,3 outlets, 4,5 Vents). When pressurised air is passed through Zeolite due to its chemical nature and atomic structure Nitrogen gets attracted and trapped inside the micropores of the Zeolite, only Oxygen and rest of the air constituents pass through it so that we can collect Oxygen enriched air collected at the outlet of the filtering device. While Filter1 filters the air, Filter2 purges out nitrogen through vent as we blocked its outlet with an On/Off DCV. Like this the system generates in vice versa until it generates the oxygen levels are reached to acceptable levels and after that it is turned off through pre-programmed micro controller with the help of sensor readings. a power supply of 12 V DC is made using transformer, capacitors, full bridge diode rectifier, voltage regulator IC, LEDs and 26 resistors to provide power to the whole circuit including control relay, and Arduino.12 V DC SPDT relay (RL1) is used to control solenoid valves connected to it at the output side. Which is triggered using a pullup 1 KΩ resistor (R2) and 2N2222 NPN switching transistor (Q1-Q6) along with 1N4007 (D5-10) diode as flywheel diode with Arduino Uno

pin 2 to pin 7. The Arduino is programmed in a way to allow compressed air to enter in canister from the inlet one at a time. And some volume of the output of that canister is used to flush another canister. And remaining part is consumed as oxygen. And after the delay is achieved the relays are switched and the above condition is switched with the other canister. And this is how the pure oxygen is separated from the compressed air.

Figure 1.2: Design and Implement an Arduino-Based Oxygen Concentrator using Arduino Esp2866.

CONCLUSION

Oxygen therapy has become an integral part of treatment and standard care for various life treating diseases such as childhood pneumonia, surgery, anesthesia, emergency, obstetric care, etc, and an oxygen concentrator is indicated by WHO as a suitable source of medical oxygen in low-resource settings, especially where cylinders and/or piped systems are unavailable. Typically, an oxygen concentrator provides $93\pm3\%$ pure medical oxygen for oxygen therapy. However, this value may go below the required limit due to several factors such as harsh environment, poor/no maintenance, prolonged operation time.

Recommendations and Future work

A prototype was developed to generate oxygen by controlling the device over Wi-Fi with an Arduino microcontroller. In the future, we suggest adding new features to the device to improve patient outcomes For example, adding a sensor to measure the patient's oxygen level.

REFERENCE

1. G. Harrison and B. Shaw, ―Prescribing home oxygen,‖ Arch. Dis. Child. Fetal Neonatal Ed, 2007; 92: 4.

2. I. C. Details, ―through Dolby Medical and Dolby Vivisol Your Transportable Oxygen Concentrator.‖

3. C. F. McDonald, A. J. Crockett, and I. H. Young, ―Adult domiciliary oxygen therapy,‖ Med. J. Aust, 2005; 183, 9: 474,.

4. C. J. LeBlanc, L. G. Lavallee, J. A. King, R. E. Taylor-Sussex, A. Woolnough, and D. A. McKim, ―A Comparative Study of 3 Portable Oxygen Concentrators During a 6-Minute Walk Test in Patients With Chronic Lung Disease,‖ Respir. Care, 2013; 58, 10: 1598–1605.

5. J. Pilcher, K. Perrin, and R. Beasley, ―The effect of high concentration oxygen therapy on PaCO2 in acute and chronic respiratory disorders,‖ Transl. Respir. Med, 2013; 1, 1: 8.

6. E. Guide, ―OXYGEN THERAPY This Essential Guide is.‖

7. J. Formulary, ―LJF T a c r o l i m u s c a p s u l e s – p r e s c r i b e b y b r a n d n a m e,‖, 2008; 35: 1–4.

8. C. F. McDonald, ―Ambulatory oxygen delivery—an answer: But what is the question?,‖ Respirology, 2019; 24, 4: 294–295.

9. M.H. Bhuyan, & M.R. Sarder, "Design, Simulation, andImplementation of a Digital Pulse Oxygen SaturationMeasurement System Using the ArduinoMicrocontroller," International Journal of Biomedical andBiological Engineering, 2021; 15(2): 105-111,[2] L. Surasura, & S. Patil, & M.

10. Ayesha, Sattikar "IoT BasedSPO2 and Temperature Monitoring Using Arduino Mega andGSM," 3rd International Online Conference on EmergingTrends in Multi-Disciplinary Research, Jan, 2022; 20-22,.[3] D.

11. Fengzhi, & H. Wen, & J. Zhao, & H. Hao, & QianqianZhang, "Design of an Instrument for Measuring Heart Rateand Blood Oxygen Based on Arduino," Journal of Robotic [accessed May, 2024; 17].

12. H. Almimi, & A. A. Dahoud, & M. Fezari, & S. Mohammad,"A Study on New Arduino NANO Board for WSN and IoTApplications," International Journal of Advanced Scienceand Engineering, 2020; 29(4): 10223-10230.

13. K. Mahesh, "Density Based Traffic Light Controller usingArduino – Nano," International Journal for Research inApplied Science & Engineering Technology, 2023; 11(I).

14. R. Sameh, & M. Genedy, & A. Abdeldayem, "Design andImplementation of an SPO2 Based Sensor for HeartMonitoring using an Android Application," Journal ofPhysics: Conference Series, 2020; 1447: 012004.

15. Kumar, D., Vertivendan, L., Velmurugan, K., M., K., Toradmalle, D. ., & Vajid Nabilal, K. Semantic Marginal Autoencoder Model for the Word EmbeddingTechnique for the Marginal Denoising in the Different Languages. International Journal of Intelligent Systems and Applications in Engineering, 2023; 11(3s): 204–210.

16. B. N. Karthik, & L.D. Parameswari, & R. Harshini, & A. Akshaya, "Survey on IOT & Arduino Based Patient Health Monitoring System," International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 2018; 3(1): 1414-1417.

17. M. H. Bhuyan, & M. Sheikh, "Designing, Implementing, andTesting of a Microcontroller and IoT-Based Pulse Oximeter Device," IOSR Journal of Electrical and Electronics Engineering, 2021; 16(5): 38-48.

18. D. T. Harjono, & A. S. Tamsir, "Biomedical Sensor ECG, PPG, and spO2 based on Arduino Which Result fromComparison with Portable," Technical Report, 2020; 1-9.

19. R. Austin, & F. Lobo & S. Rajaguru, "GSM and ArduinoBased Vital Sign Monitoring System. The Open Biomedical Engineering Journal, 2021; 15(1).

20. M. A. Miah, M. A, & M. H. Kabir, & M. S. R. Tanveer, &M. A. H. Akhand, "Continuous Heart Rate and BodyTemperature Monitoring System using Arduino UNO andAndroid Device," International Conference on ElectricalInformation and Communication Technologies, 2015; 2: 189-194,