e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:01/January-2023 Impact Factor- 6.752 www.irjmets.com

LOW-COST VENTILATOR USING PIC

Pradip Magadum[*1], Abhishek Chavan[*2], Nilesh Mane[*3], Prof. D.B. Shivpuje[*4]

[*1,2,3]Student Of E&TC KIT Shelve Pandharpur, India.

[*4]Asst. Prof. Of E&TC KIT Shelve Pandharpur, India.

DOI : https://www.doi.org/10.56726/IRJMETS32832

ABSTRACT

This paper considers a low-cost ventilator that is based on a manual resuscitator bag (Ambu bag) to pump air into the lung of a patient who is physically unable to breathe. To maintain the pressure of oxygen level to improve the patients breathing by regulating the flow of oxygen in the lungs as an intensive therapy. A contradictory motion is used by a ventilator to inflate the lungs by pumping type motion. The ventilator functions while not a human operator because it delivers breaths through the compression of an associate degree orthodox bag-valve mask. It satisfies its energy wants from an electrical motor having a battery power of three to twelve volts DC. Different functions got to be performed for the aim of ventilation i.e. pressure and needed range of breaths per minute are managed by a simple-to-use input board comprising of buttons. Adjust the time duration for inhalation to exhalation ratio. The low-cost ventilator design oxygen sensor and pressure sensor controlled by the microcontroller. This project work on a mechanical method to provide oxygen to the patient. This project gives comfortable treatment to the patient, and monitors and controls the pressure of oxygen level.

Keywords: Ventilator Bag, Oxygen Sensor, Pressure Sensor, DC Motor, PIC Microcontroller.

I. INTRODUCTION

A low-cost ventilator, whose functionality can carry a patient from early admission to their final discharge from the hospital, this device would produce a high, continuous flow of oxygen, as used in High-flow Nasal Cannulas and CPAP devices [3]. The ventilator would also need to be able to ventilate in both assisted and mandatory modes, depending on the state of the patient [3]. In case of lung damage, the use of mechanical ventilation enables an increase in the amount of oxygen delivered to the patient through an increase in inspiratory pressure, which forces the oxygen to reach inside the lungs [8]. Mechanical ventilation systems help to increase blood oxygen saturation to levels compatible with life, therefore a reduction in mortality [8]. A low-cost ventilator, whose functionality can carry a patient from early admission to their final discharge from the hospital, this device would produce the primary gas delivery power source for the O2U ventilator from the pressurized medical gases which are plumbed into the hospital and subsequently into the ventilators [9]. The goal for this ventilator was a design that would permit the rapid manufacture of relatively inexpensive ventilators that could withstand long-term storage yet be rapidly deployed to the patient care arena and still reliably deliver time-cycled, precise gas volumes to patients [9]. Mechanical ventilator devices that are currently in short supply, to meet the peak ventilator demands, a series of low-cost have been proposed [10]. While many of these designs remain low cost, such bag valve mask-based designs are required in an intensive care unit [11]. Mechanical ventilators that use air and oxygen from hospital networks are the most commonly used in intensive care units because sensors that detect if the patients intend to breathe and assist them with adequate respiratory support [12]. Here in, we have designed a low-cost, easy-to-assemble, portable automated AMBU resuscitator system with proper air exhaust assembly that can be easily scaled, to fight the ongoing pandemic. The device provides precise control over various ventilation parameters, such as PEEP, peak pressure, tidal volume, and I/E, while operating in pressure mode [14]. Advancements in engineering led to positive-pressure ventilators becoming the primary mode of ventilation. Further research and technological development of ventilation and sensor technology have resulted in the widespread implementation of positive end-expiratory pressure (PEEP) as well as O_2 and CO_2 monitoring [15].

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:01/January-2023 Impact Factor- 6.752 www.irjmets.com

II. BLOCK DIAGRAM

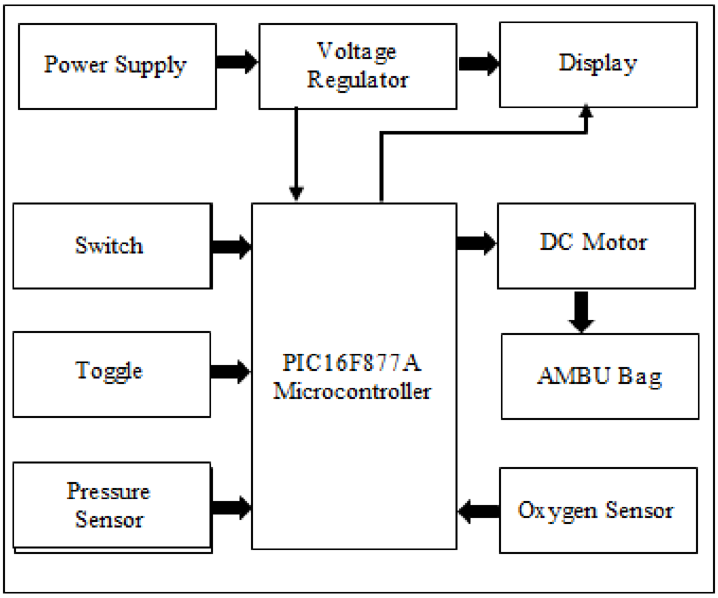

Fig.1: Block Diagram of the low-cost ventilator.

III. BLOCK DIAGRAM DESCRIPTION

1) Power Supply:

The power supply consists of four stages namely transformer, rectifier, filter, and regulator. A transformer is a stepdown transformer taking an input voltage of 230V or 240V AC and giving an output voltage of 12V AC with a current rating of 500 mA. This 12V AC is rectified by a bridge rectifier consisting of four diodes, which converts the DC signal but some part of the AC signal is mixed with the output voltage, we have to use a capacitor to filter out the AC of the output signal. There are mainly three types of rectifiers Half wave, Full wave, and Bridge rectifier. Out of these three, we have used a bridge rectifier since it gives more efficiency. The regulator removes the entire ripple and gives pure DC.

2) Voltage Regulator:

A voltage regulator is used after the filter capacitor to generate a constant DC voltage supply of 5V. We have used 7805 as a voltage regulator it is a three-pin IC which are namely input, ground, and output. We have to give an output of the filter capacitor to the input of the regulator, and we get 5V at the output pin of the regulator.

3) LCD Display:

We are going to use a 16*2 alphanumeric Liquid Crystal Display (LCD) which means it can display alphabets along with numbers on 2 lines each containing 16 characters. It can be used to display the various options and all the readings that have been stored in the EEPROM. The LCD is an alphanumeric display which means that it can display Alphabets, Numbers, as well as special symbols thus LCD, is a user-friendly Display. It operates on a 3 v to 15 v power supply [14].

4) PIC16F877A Microcontroller:

In PIC16F877A microcontroller is having ports A, B, C, D & E. Memory is not the PIC16F877A is an 8-bit CMOS Flash-based Microcontroller. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 Channels of 10-bit Analogue to Digital Converter, 2 Capture/Compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial peripheral interface or 2-wire inter-integrated circuit (I2C) bus and Universal Asynchronous Receiver Transmitter (USART). The data EEPROM and flash program memory are readable and writable during normal operation. It operates on a 2 v to 5.5 v power supply to control the whole circuit. This has 40 pins, it operates on 20mhz frequency, Ram size 368 Bytes, speed of the CPU is 5 million instructions per second it works in this way to control the circuit.

5) Oxygen Sensor:

The MAX30100 is an integrated pulse oximeter and heart rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximeter and heart-rate signals. It operates on 1.8 v to 3.3 v but we supply this sensor to 3.3 v because IR_LED operates on 3.3 v and senses the signal. This oxygen sensor has 14 pins, in this 7 pins are built and 7 pins connect the output device to get the result on display [10].

6) Switch/Pushbuttons:

A Push Button switch is a type of switch that consists of a simple electric mechanism or air switch mechanism to turn something on or off. Depending on the model they could operate with momentary or latching action functions. The button itself is usually constructed of a strong durable material such as metal or plastic. Pushbuttons we use to operate high-voltage operating devices and also to on or off [14].

7) DC Motor:

The G-12 N20 Micro Gear 6V 100 RPM DC Motor (High Torque) is a lightweight, high torque, and low RPM motor. It is equipped with a gearbox assembly to increase the torque of the motor. It has a cross-section of 10*12 mm, and the D-shaped gearbox output shaft is 9 mm long and 3 mm in diameter. It operates on a 3V to 12V power supply. When we supply 3V 50 RPM, 6V 100 RPM, and 12V 200 RPM (Revolution Per Minute) [1].

8) AMBU Bag:

This is an Ambulatory Manual Breathing Unit bag, which means if you bring this device you go outside of the city or village it will operate in an emergency. It consists of a self-inflating bag, a one-way valve, a mask, and an oxygen reservoir. When we switch the motor it rotating then the mechanical rod pushes the Ambu bag. When the mechanical rod pushes the Ambu bag then air comes outside and oxygen is reserved in the reservoir bag. In this device, we provide 100% oxygen to the patient using an oxygen tube this tube inlet only oxygen from the air to the reservoir bag and reserves it. This Ambu bag has various sizes to requirements of patients like 240 ml, 500 ml, and 1600 ml bag sizes for infants, children, and adults. This device help in emergency time to breathe patient [1-3].

9) Toggle/Potentiometer:

This device is operate and adjusts the input signal to the output signal. This adjustable or Variable resistor is PCB mountable and has 3 terminals. The voltage between the terminal varies as the preset is rotated. The Variable resistors are used for variable voltage as per the need in the circuit. The device operates low voltage also high voltage to adjust how much output they need [14].

10) Pressure Sensor:

This pressure sensor senses how much oxygen we provide to the patient and displays it on a crystal liquid display. HX710B Atmospheric Pressure Sensor Module. This barometric Pressure is optimized for altimeters and Variometers with ultra-low power, 24-bit ADC with internal factory-calibrated coefficients. It operates on 2.6V to 5.5V and senses the signal. This sensor has 8 pins 4 pins are inbuilt and the other 4 pins are connected to the outside to get output and display on LCD [2].

IV. METHODOLOGY

Mechanical ventilators must (i) the respiratory frequency, (ii) the ratio of inspiration-to-expiration at each respiratory cycle, and (iii) the air volume supplied to the patient. In the mechanical ventilator described in this paper, the air and oxygen supply flows through the corresponding limb and reaches the patient's lungs [2]. Many different designs have been authorized by the FDA for the EUA and many will likely not be utilized. Our design is intended to exist after the EUA phase has passed and as such, this design required some extra thought for its usefulness in the long term. In this, they use Arduino to control the device [3]. We carried out a cost analysis of the various ICUs that transferred patients to the CVDU by year from 1993 through 1998. CVs were established by year for the same period. We then calculated the cost-effectiveness of transferring these patients for care from each high-cost ICU to the lower-cost CVDU. Ventilator weaning and mortality rates were also determined [4]. We reviewed MEDLINE (January 1966-April 2007) and bibliographies of the retrieved articles for all observational or interventional studies that examined the incidence, microbiology, outcome, and prevention of VAP in ventilated adults in developing countries. We evaluated the rates of VAP using the

National Healthcare Safety Network (NHSN) definitions and the impact of VAP on the intensive care unit (ICU) length of stay (LOS) and mortality, and the impact of interventions used to reduce VAP rates [9]. In the ventilator system, we use the breath ventilator a passive value, and a high-efficiency particulate air filter. Actuators and sensors to develop ventilator devices [10]. The system consists of two gas inlets for hospital-supplied O2 and ambient air supplied through a blower assembly respectively, a mixing tank with safety valves, pressure sensors, humidity exchanger, filters, and standard inhalation and exhalation [11]. An electronic scheme is also required to generate a versatile printed circuit board (PCB) to enable the coupling of the electronic components. Some boards are being developed to implement mechanical ventilators, such as those presented in addition, electronic sensors should measure the flow in the inhalation and expiratory lines, airway pressure, and the level of oxygen delivered to the patient [12]. We used the net benefit regression approach to perform a cost-effectiveness analysis comparing two interventions—nasal oxygen and BCPAP—targeted to treat neonates with respiratory difficulty. The overall outcomes are reported using incremental cost-effectiveness ratio (ICER) and incremental net benefit (INB) [13]. In this system, they use the Arduino technique with motors, and sensors to develop a low-cost ventilator. We used the net benefit regression approach to perform a cost-effectiveness analysis comparing two interventions—nasal oxygen and BCPAP—targeted to treat neonates with respiratory difficulty. Cost-effectiveness ratio (ICER) and incremental net benefit (INB) [14]. I read all problems of this ventilator system we should develop a simple and useful device to better use in emergency times. This above system problem is to overcome and develop a good ventilator. In our device we should be using two sensors, first one is an oxygen sensor to sense the oxygen level and display it on LCD, and the other one is a pressure sensor that senses the pressure of oxygen we should provide the patient. We should change the adults and children to provide oxygen with proper BPM and BPL to the patient. We should use a PIC microcontroller to control the whole circuit and using this IC our hardware should be less and the cost is also less. We should run this device and use an embedded c programming language to run this system carefully. This system is very useful and treatable.

V. CONCLUSION

We hope that the project should serve the cause it has been made for and saves a lot more lives. This project will work as artificial lungs for people having breathing issues. It emulated healthy and unhealthy patients to illustrate the potential benefits of the derived mechanical ventilator. This work is simple to control and easy to use, nobody needs a medical specialist to run it, and we can use it at home and in emergencies. This project provides how much oxygen is required to breathe the patient. It is easy to use and monitor and control the pressure of oxygen level. In this project, a prototype device to assist the patients who can partially breathe on their own is developed. This device is provided with a very basic design and reliable structure that is easily acceptable by the patient. The main focus of this project is to minimize the components and increase the efficiency of the device so that while using this device the patient, should feel as comfortable as the normal ventilator.

Table No. 1

Sr. No.	Age	Health Condition	SPO2(In Medical Device)
1	Child	Healthy	95-100
2	Adult	Healthy	95-100
3	Child-Adult	Unhealthy	< 90

VI. REFERENCES

[1] Madiya, M, (2022). Low-Cost Ventilator With BGM And Oximeter, VIVA-Tech International Journal for Research and Innovation, 1, 1-6.

[2] Acho, L, (2020). Low-Cost Open Source Mechanical Ventilator with Pulmonary Monitoring for COVID-19 Patients, Actuators, 1, 1-14.

[3] Raymonda, S. J, (2020). A low-cost, rapidly scalable, emergency-use ventilator for the COVID-19 crisis, a CC-BY-NC-ND 4.0 International license, 1, 1-14.

[4] Gracey, D. R, Issue 5, May 2000. The Chronic Ventilator-Dependent a lower-Cost Alternative to

Intensive care, Mayo Clinic Proceedings (ELSEVIER), 75, 445-449.

[5] Rakib, A. Al. Md, (2021). Low-Cost Pulmonary Ventilator for patient Monitoring for Covid-19 Disease, European Journal of engineering and technology Research, 6, 154-159.

[6] Corey, R. M, (2020). Low-Complexity System and Algorithm For an emergency Ventilator Sensor and Alarm, IEEE transaction on biomedical circuits and systems, 14, 1088-1096.

[7] Fernandez, FJ. V, (2020). A Low Cost and Fully Functional Ventilator Indicated for Application in COVID-19 Patients, sensors (MDPI), 1, 1-20.

[8] Raymond, S. J, (2022). A low-Cost, highly functional, emergency use ventilator for the COVID-19 crisis, AAMI Journal, 5, 1-10.

[9] Arabi, Y, (2008). Ventilator-Associated pneumonia in adults in developing countries, International Journal of Infectious Diseases, 4, 58-68.

[10] Hewing, L, (2020). Volume Control of Low-Cost ventilator with Automatic Set-Point Adaptation, ARXIV, 1, 1-6.

[11] Shah, Y, (2020). Proposal for a low-cost high fidelity ventilator for COVID-19 pandemic, Researchgate, 1, 1-9.

[12] Flor, O, (2022). Emergency Mechanical ventilator Design Low-Cost and Accessible Components, electronics (MDPI), 5, 1-18.

[13] Chen, A, (2014). Cost-effectiveness analysis of a low-cost bubble CPAP device in providing ventilatory support for neonates in Malawi, BMC Pediatrics, 1, 1-12.

[14] Kumar, M, (2021). A Low-cost Ambu-Bag Based Ventilator for Covid-19 Pandemic, IEEE, 1, 1-8.

[15] Pivik, W. J, (2022). Dynamic Modeling of A Low- cost Mechanical ventilator, IFAC Papers on line 55-37(2022) 81-85.