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Clinical Oxygen Monitor

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Abstract— ***In medical industry, oxygen (O_2) is widely used for patients from Emergency to Operation Theatre and from ICUs to Wards, which is most important for their survival. Most of the Accidents in the OTs, ICUs, NICUs, and PICUs occur due to deficiency of O_2 supply to the brain which always helps to keep the brain active and to maintain consciousness. This situation occurs, once when O_2 level is set (FiO_2) in the ventilator as per the requirement of patient and in most cases it is not monitored that whether the set level is completely delivered to the patient. To overcome this, we are developing an O_2 monitor which is a device that senses the percentage of Oxygen from any equipment like Ventilator, Incubator, Heart-lung machine, Anaesthesia Gas Machine, O_2 Concentrators etc.***

Keywords— ***Oxygen delivery, percentage of oxygen, FiO_2 measurement***

I. INTRODUCTION

Oxygen deficiency is increasingly being an important reason for theatre accidents. It may be due to ignorance of the technician or equipment malfunction. The patient victims who die because of oxygen deficiency caused by anesthesia over dose are increasing day by day.

Maintaining O_2 Saturation Level in our Blood Stream is very crucial for our stability. It is very important to maintain Partial Pressure of O_2 in Blood at 80 mmHg or O_2 Saturation at least to a level between 94 to 98% to maintain consciousness and keep the brain oxygenated and to stay awake. Patients who are deprived of O_2 to the required level may slip into coma and that could be fatal.

The O_2 monitor contains an O_2 Sensor that senses the concentration of Oxygen and transmits analog Signal to analyser to convert as Digital Signal that tells the clinicians the proportion of O_2 in percentage. When the equipment malfunctions, the Set percentage of O_2 is not delivered to the

patient and in that situation the O_2 analyser will detect this anomaly and immediately will inform that Oxygen in not being delivered as per the patient's requirement.

II. MONITORING OXYGEN

As recovery from irreversible shock of oxygen deficiency is difficult, clinical indications of shock and inadequate Do2, such as increased heart rate, decreased BP, reduced urine output, and reduced skin temperature, are neither sensitive nor specific. These parameters are slow to change during the compensation phase, and abnormal values may be seen only in the late stages of diminished Do2.

Serum lactate, anion gap, base excess, and pH may be used to assess the severity of metabolic acidosis and shock, but they are global measurements and are not sensitive to regional hypo perfusion.

III. CIRCUIT DIAGRAM

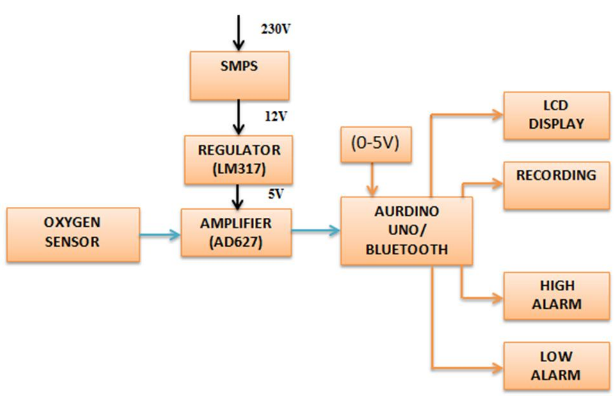

FIG 1: Block Diagram of Clinical Oxygen Monitor

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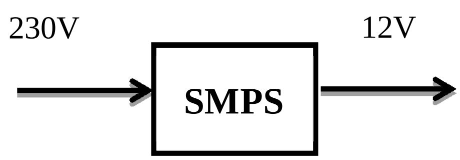
A. Components description

1) *O_2 SENSOR:* It can be of Galvanic Cell, Fuel Cell, and paramagnetic Cell, Ultra-sound etc. All these sensors sense the % of O_2 in a particular environment and transmit to the Analyser for further display in % of O2. These sensors generate Electrical Analog Signal according to the % measured. This Analog Signal is then converted as Digital in the Analyser for further Display.

Technique, principle and limitations of oxygen analyzers in anesthesia machines

Technique	Principle	Limitations
Paramagnetic oxygen analyser	Oxygen being paramagnetic because of unpaired electron is attracted in a magnetic field	Affected by water vapours and requires water trap
Galvanic oxygen analyser (Fuel cell, Hersh Cell)	Based on a chemical phenomenon generated by oxygen molecules	Limited life span
Polarographic oxygen analyser (Clark electrode)	Based on a chemical phenomenon generated by oxygen molecules	Requires replacement because of limited life span of Teflon

2) SMPS**:** To avoid the noise an SMPS is being used. The input to the SMPS is 230V and the output of SMPS is 12V.Thus,the output from the SMPS is given to the regulator.



3) Regulator**:** The LM317 is adjustable regulator used to convert 12V to 5V. Thus, the 5V is being given to the amplifier.
4) Amplifier**:** The oxygen cell voltage is given as an input to the amplifier. Then, voltage is amplified by using

AD627 which is an instrumentation amplifier. The output is given to the Arduino.

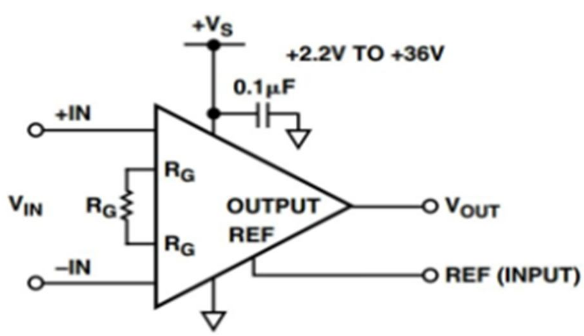


FIG 2: Circuit Diagram of AD627

B. Gain calculation:

From the data sheet of amplifier,

Gain=5+(200 KΩ/RG)

C. ARDUINO UNO:

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED,

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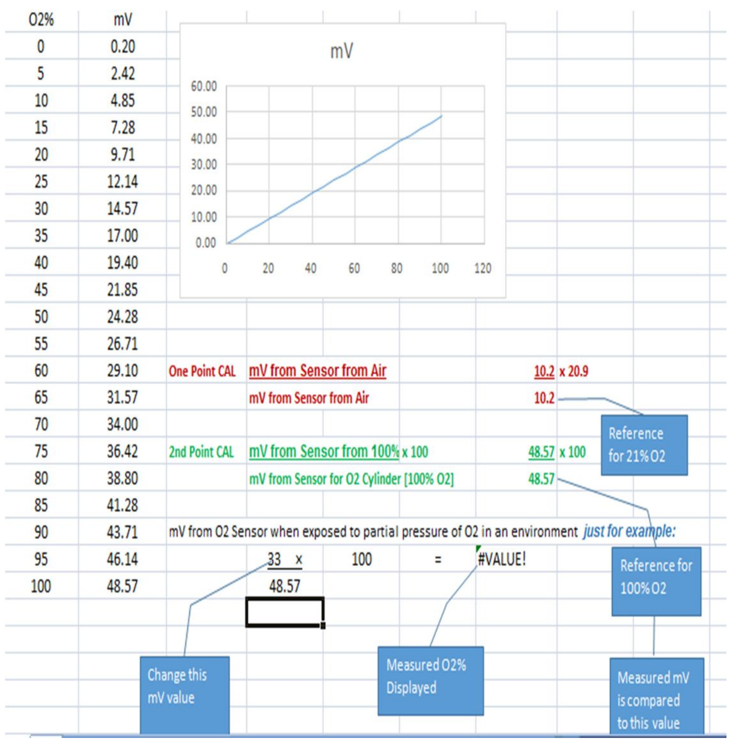
publishing something online. The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It 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. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

IV. METHODOLOGY

The oxygen sensor which is self powered(no need input) when exposed to atmosphere. The range of output freom the oxygen sensor is around 13mV. Then it is given to the amplifier (AD627).The supply for the amplifer is made from the SMPS of 230v and which is regulated by the use of regulator (LM317).It delivers the output in form of 5V,then it is given as input to the ARDUINO UNO where the range of(0-5V).It is further connected to the LCD display which delivers the level of oxygen and recording is made in order to use it for furture verification. It can drawn by SD card. Alarm are used in order to display the low and high level of o2 % level .For alarm we can set 2 limit values one is for indicating the low limit another for high limit. For low limit low alarm if it exceed it and moves on higher limit then it automatically turn it into high alarm.Low alrm is like warning and high alarm means ask theconcerned person to take immediate action.

A. Lookup Table



O2%	mV
0	0.20
5	2.42
10	4.85
15	7.28
20	9.71
25	12.14
30	14.57
35	17.00
40	19.40
45	21.85
50	24.28
55	26.71
60	29.10
65	31.57
70	34.00
75	36.42
80	38.80
85	41.28
90	43.71
95	46.14
100	48.57

FIG 3: Graph Which Shows the Linearity of the Sensor

Formula for converting Mv to oxygen percentage**:**

$$\left(\frac{\text{Current mv from sensor(A)}}{\text{mv from sensor in the air(B)}} \right) \times 21\%(C)$$

V. CLINICAL SIGNIFICANCE

They are mostly used in Anaesthesia Gas Machines (AGM), where they are divided in ranges from (1) High-end (2) Mid-segment & (3) Low-end.

A. The High-end AGM is built along with a Gas Monitoring System which contains an O_2 Monitor.
B. The Mid-Segment contains only the AGM and it's devoid of Analyser or Monitor.
C. The Low-end AGM is cheap both in price and quality.

In India, the mid-segment and the low end AGMs are majorly used in the hospitals. In order to overcome the shortcomings of that, an oxygen monitor is used.

D. It is used in the ambulatory monitoring of oxygen
E. In determining % of Oxygen in Ventilator, Incubator, Heart-lung machine, Anaesthesia Gas Machine, O2 Concentrators and controlled environments-incubators.
F. They are used physiologically in Scuba diving ,fire fighting, mountain climbing
G. In the biological industry of fermentation, beverage and food packing, they extend their significance.
H. They are used in industries for Combustion control, safe operation of chemical plants, fuel and pollution management.

VI. CONCLUSIONS

O_2 Analyser is considered as life saving equipment as it measures the exact O_2 level administered to patient as against set level on equipment. All these analysers are imported and it costs much higher than the equipment on which it is used. Indigenous design of O_2 Analyser will not only make the price cheaper but also available for all IUs and OTs for better patient management.

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