

Literature Review: Air Oxygen Level Monitoring System

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Abstract

Oxygen is a very important gas for humans. The need for oxygen around the plant is very low because the exhaust gas from various factories often becomes pollutants, one of which is the cement industry. The oxygen content needs to be known so that the level of vigilance of workers and the community is higher. For this reason, it is necessary to make a monitoring device for oxygen content. In this view will be discussed several gas sensors, especially oxygen sensors. In addition, Arduino microcontrollers and Raspberry Pi microprocessors were also discussed. The goal is to be able to determine the type of oxygen sensor as a detector of oxygen levels in the air. The discussion of microcontrollers and microprocessors is also a determinant of the motherboard connected to the oxygen sensor. Thus, the explanation of this review can be used to develop a monitoring system for oxygen content in the air. The research method used is in the form of literature studies. Literature study is the process of finding research data or information by reading scientific journals, reference books, and articles about oxygen content monitoring devices. This tool functions as a gas analyzer by choosing the MQ-135 sensor as an oxygen sensor because it is more affordable and easy to obtain which is supported by the Raspberry Pi device.

Keywords: MQ-135 Sensor, Raspberry Pi, Oxygen, Gas

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INTRODUCTION

A natural resource that is very important for life on earth is air. Air has several contents, namely nitrogen (N₂), oxygen (O₂), argon (Ar), and carbon dioxide (CO₂) (Khairah et al., 2013). From the content of the air, oxygen plays a major role for the survival of living things with a total of 20.95% highest after N₂ (Farida 2004; Giddings 1973). Oxygen is formed through photosynthesis as a process of making food in cyanobacteria, and algae (Nurmaeli and Taifur 2015). Oxygen is industrially obtained through a multilevel distillation process of liquid air that uses zeolite as a separator of carbon dioxide and nitrogen from the air, or electrolysis of water.

In addition, oxygen also functions in the production of steel, plastics, and textiles. Oxygen is also a rocket propellant and supports work functions in flying aircraft, submarines, space flight, and diving. Oxygen is also the main component for sustainability in the cement manufacturing process (Rohmawati & Dzulkifli, 2017). Oxygen is useful in making cement occurs in the combustion process that occurs in kiln furnaces due to the combination of coal fuel with oxygen which has a high pressure of around 1,500°C (Putri et al., 2019). Cement has components, namely dicalcium silicate (2CaOSiO₂ or C₂S), tricalcium silicate (3CaOSiO₂ or C₃S), tricalcium alumina (3CaOAl₂O₃ or C₃A), and tetra calcium aluminate ferrite (CaOAl₂O₃ or C₄AF) (Putri et al., 2019). Making cement is divided into two processes, namely the wet process and the dry process. Wet process is the process of mixing all raw materials with water then crushed and evaporated, then burning using fuel oil (bunker crude oil). Meanwhile, dry process is a process that goes through milling and blending

techniques and then burned using coal fuel. The dry process causes evaporation because combustion is carried out at a temperature of 900°C. The process produces residual products, including sulfur trioxide, soluble silica, iron and aluminum oxide, calcium, iron oxide, magnesium, phosphorus, free lime and alkali. Such residues can affect the environment and humans. One of them is the cause of disease or disorders of the respiratory tract (Mengkidi, 2006). Especially if people are not aware of themselves and their surroundings so that in the future the disease is likely to attack. Awareness of the condition of the surrounding air needs to be increased, for example by knowing the gas levels in the air.

Gas levels can be determined using a gas analyzer. A gas analyzer is an instrument as a measure of the proportion and composition of gas combinations that applies sensors as a gas detector and meter. The working principle of a gas analyzer is to take a gas sample through a probe then go to each sample cell. The sample gas will be compared with standard gas through a transmitting system that will produce a wavelength difference and be converted into an analog signal and receiver (Khairi, 2016). The development of science and technology makes more and more new discoveries, such as gas analyzer device innovations. Gas analyzer devices are capable of measuring gases using connected sensors, such as the MG-811 sensor to measure carbon dioxide gas levels, the MQ-7 sensor for carbon monoxide, or the TGS-2201 sensor as a measure of HC gas levels and nitrous oxide genes (NO_x). These sensors must be connected to a microcontroller or microprocessor. The main function of the component is as the controlling and processing center of the desired command. Microcontrollers are commonly used, for example Arduino. Meanwhile, an example of a microprocessor is the Raspberry Pi.

Based on this, in this review will be discussed several gas sensors, especially oxygen sensors. In addition, Arduino microcontrollers and Raspberry Pi microprocessors were also discussed. The goal is to be able to determine the type of oxygen sensor as a detector of oxygen levels in the air. The discussion of microcontrollers and microprocessors is also a determinant of the motherboard connected to the oxygen sensor. Thus, the explanation of this review can be used to develop a monitoring system for oxygen content in the air.

METHOD

This study uses research methods in the form of descriptive research and literature studies. First, conduct a literature study. Literature studies are carried out by searching for research data or information by reading scientific journals, reference books and articles on the internet about sensors that are useful as gas analyzers. Secondary data in the form of journals that can be accounted for in the form of national journals and international journals related to sensors as gas analyzers and motherboards used.

There are several stages carried out to obtain information or data, including conducting library data collection methods, then reading and recording, and managing research materials. The second stage is research that uses a qualitative approach. This is done after obtaining information or data from the journal about the oxygen sensor as a gas analyzer in accordance with Figure 1.

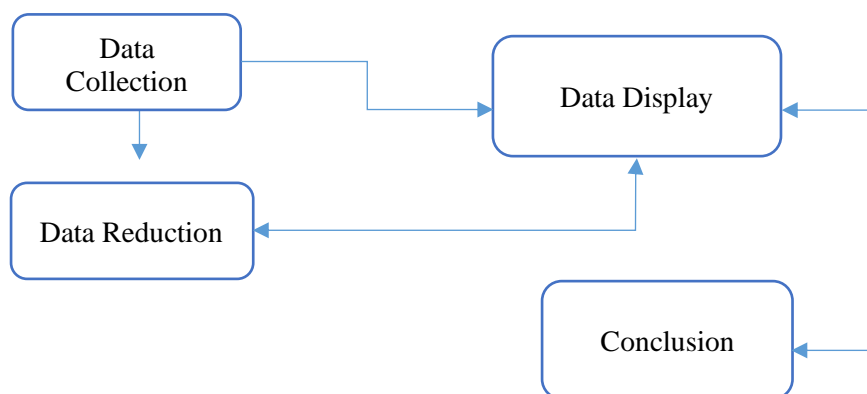


Figure 1. Qualitative Data Analysis

In qualitative data analysis consists of four stages. First, carry out data collection, namely data collection or data collection (data collection). Information or data is carried out through the process of collecting data in the field from journals or articles. Second, the stage of reduction or reduction of data. The stage of data reduction is to summarize the topic so that it focuses more on what is important and gets a clear picture to take the next data. Third, data presentation (display data). Data presentation (display data) is a form of presentation in the form of narrative text in the form of short descriptive, charts, relationships between subjects, and others.

Fourth, draw conclusions (verification). The last stage is to conclude from several journals, books, or articles into one appropriate conclusion.

RESULTS AND DISCUSSION

Based on the results of a study of several journals or articles related to oxygen sensors in gases as *gas analyzer* devices according to Table 1.

Table 1. Journal Review About Oxygen Sensor and Microcontroller/ Microprocessor

No.	Journal Review	Sensor Type	Study Results
1.	This air pollution monitoring system was carried out 4 trials, including the 1st study (CO = 40 ppm, alcohol = 149 ppm, air declared fresh), the 2nd study (CO = 41 ppm, alcohol = 149 ppm, air declared not fresh), the 3rd study (CO = 45 ppm, alcohol = 157 ppm, air declared fresh), the 4th study (CO = 33 ppm, alcohol = 120 ppm, air declared fresh) (Ms. Kshitija Tanaji Kamble et al., 2022).	Sensor: MQ-2 sensor (alkohol) dan MQ-7 sensor (CO ₂) Motherboard: Raspberry Pi	MQ-2 and MQ-7 gas sensors are used as analog sensors connected to the ADC. The ADC is further connected to the Raspberry Pi equipped with a power supply. The output of the Raspberry Pi is sent to the IoT thing speak platform to graphically monitor it using a mobile phone, laptop or computer system.
2.	Paramagnetic detectors are only useful as a separator between oxygen gas and other gases. The content of oxygen can affect the combustion system, the quality of cement and exhaust gases, such as CO. The combustion process of cement raw materials is the most on the 11th day, namely December 7, 2016 with an Oxygen content value of 8.03% and 11.5% for AN1 and AN2 (Rohmawati & Dzulkiflih, 2017).	Paramagnetic detector as gas analyzer O ₂	Working Principle of Paramagnetic Detector is that a sample of the incoming gas will be detected by the paramagnetic detector. Oxygen has paramagnetic properties so that the gas will be drawn by the paramagnetic detector and then forwarded to the RTD Pt100 sensor to find out the value of oxygen content, while other gases will be discharged.
3.	The results showed the average condition of pollution in traffic activities, namely 7.06 ppm for CO and 4.77 ppm for CO ₂ which exceeded the threshold. Meanwhile, for NH ₃ and C ₄ H ₁₀ respectively it is 0.025 ppm and 0 ppm which is below the threshold. Thus, it can be concluded that those that produce pollutants as combustion activities in land transportation are CO and CO ₂ (Mashuri & Zulfa, 2021).	Sensor: MQ-6 sensor (CO ₂ and smoke), MQ-7 sensor (CO, LPG, and CH ₄), MQ-135 sensor (butane and air quality), and DHT-11 sensor (humidity and temperature) Motherboard: Arduino Uno	A monitoring tool that determines air quality and component quantity. The prototype consists of an MQ-6 sensor for CO ₂ and smoke detection, an MQ-7 sensor (CO, LPG, and CH ₄), an MQ-135 sensor (butane and air quality), and DHT-11 (humidity and temperature), and an Arduino as a microcontroller.
4.	The methane gas concentration measurement system uses the MQ-4 sensor as a multigas detector for the calibration and characterization process on the equipment made. The tool was successfully made and can measure methane gas concentrations with a range of 0% - 20% LEL or equivalent to 0 ppm - 10,000 ppm with an average error	Sensor: MQ-4 sensor (CH ₄) Motherboard: Raspberry Pi	Parameters require calibration to determine the correctness of the designation values of measuring instruments and measuring materials by comparing them to standard measuring instruments, namely multi-gas monitors M40. This

No.	Journal Review	Sensor Type	Study Results
	of 4.8% and a maximum error of 24.6% at low concentrations (Bachtiar et al., 2019).		process is useful for determining the deviation of the correctness of the value of the measurement instrument and ensuring measurement results in accordance with international and national standards.
5.	Research on the manufacture of oxygen, humidity, and temperature measuring instruments has been carried out. The measuring instrument made consists of a power supply, a non-reversing amplifier, a KE-50 oxygen sensor, a SHT11 module, and an ATmega8535 microcontroller module. The determination of the characteristic equation of the KE-50 sensor is obtained from the multiplication of the sensor output voltage in the free state with the characteristic equation of the amplifier that has been characterized. The correction factor in the voltage characteristic equation = $39.852x + 0.0117$ V is 0.0117 and $R^2 = 1$ (Ekawati et al., 2017).	Sensor: KE-50 sensor (O ₂) Motherboard: Microcontroller ATmega8535	The results of determining the characteristic equation of the KE-50 sensor obtained the voltage characteristic equation = $39.852x + 0.0117$ V which forms a linear curve with the value of x is oxygen.
6.	The CO ₂ content in the monitoring tool made resulted in consecutive average values, namely 549.18 ppm for rural areas with a comparison of 523.75 ppm and 666.29 ppm for urban areas with a comparison of 658.75 ppm. Thus, it can be concluded that the designed tool is able to detect CO ₂ levels in the air in both rural and urban areas. The level of accuracy is 99.32% in rural areas and 99.86% to monitor CO ₂ content in urban areas. The results of this reading can be seen on smartphones that have installed the udara quality monitoring application (Rochmania et al., 2021).	Sensor: MQ-135 sensor (CO ₂) Motherboard: Nodemcu ESP8266	The CO ₂ content monitoring tool uses a NodeMCU ESP8266 microcontroller and an MQ-135 sensor. The research was conducted in two places, namely in Panekan, Magetan Regency and Ketintang Surabaya City.
7.	To avoid acidosis in patients with chronic obstructive pulmonary disease or patients with atelectasis by oxygenation, oxygen saturation should be maintained between 88% and 92% and oxygen flow rate. The monitoring device detects oxygen levels and air pressure in oxygen gas using the OCS-3F sensor. The average result obtained for air pressure (flow) 2 L/min is 1.98 L/Min. Meanwhile, the average oxygen content is 84.84% (Kuspranoto, et al., 2022).	Sensor: OCS-3F sensor (air pressure and oxygen level) Motherboard: Arduino Uno	Each experiment was tested for standard deviation (standard deviation) on each reference regulator in L/min, namely 2, 3, 5, 6, and 7.
8.	Water quality monitoring devices using Raspberry-Pi and wireless networks (Ankush & Patil, 2017)	Motherboard: Raspberry Pi	It uses real time data at regular intervals sent to a central server via Raspberry Pi and Zig-Bee modules. The server automatically updates the

No.	Journal Review	Sensor Type	Study Results
			database with the latest parameter values. The Raspberry Pi is connected to sensors, namely temperature, pHm turbidity, and dissolved oxygen.
9.	This Raspberry Pi-based air quality monitoring tool measures particular matter, CO, CO ₂ , temperature, relative humidity, and pressure. The study was conducted in the morning and evening with successive results, namely particular matter (86 ppm and 73 ppm, CO (98 ppm and 98 ppm), CO ₂ (452 ppm and 456 ppm), temperature (17°C and 24°C), relative humidity (54.6% and 22.4%), and pressure (101.3 kPa and 98.3 kPa) (Kumar & Jasuja, 2017)	Sensor: DHT-22 and BMP-180 sensors (temperature, humidity, pressure); MQ-9 and MQ-135 sensors (carbon monoxide and carbon dioxide) Motherboard: Raspberry Pi	Use of the Node Red application as an Internet of Things (IoT) application of Things (IoT).
10.	The monitoring system uses the MQ 135 sensor as a smoke detector, Arduino Uno As an input processor from sensors, Arduino Ethernet Shield that has been connected by a modem will send sensor input data to the Thingspeak web server and then will be displayed to smartphones that use the internet as a transmission medium between smartphones and smoke shorteners. The results of trials prove that this system can monitor smoke anywhere as long as the smartphone is still connected to the internet (Hardika & Nurfiana, 2013).	Sensor: MQ-135 sensor (cigarette smoke) Motherboard: Arduino Uno	Systems using the MQ-135 sensor do not respond when a range of 1,500 meters is used. The connection will be disconnected and the network has no power so there is no connection response time and application response time.

Sensor MQ-2, Sensor MQ-4, Sensor MQ-6, Sensor MQ-7, Sensor MQ-9, Sensor MQ-135, Sensor DHT-11, Sensor KE-50, Sensor OCS-3F, and Sensor BMP-180 are among the sensors that are used according to this literature review. The sensors in question each have unique specifications and functions. To detect gases like LPG, methane, carbon monoxide, and alcohol, the sensor MQ-2 is used. The sensor in question has a high threshold for gas-gas sensitivity and is frequently used in applications for gas alarms, gas detection, and gas-related security systems (Lowongan et al., 2015). Gas can be detected by Sensor MQ-2 between 200 and 10,000 PPM (Kamble et al., 2022). The Sensor MQ-4 is a gas sensor designed specifically to detect methane gas (CH₄) within an enclosure. This sensor is typically used in gas detectors for homes and industrial gas leak detection systems. MQ-4 is able to respond quickly and accurately to gas metana at rates ranging from 300 to 10,000 PPM, which makes it particularly useful for detecting and preventing fire (Bachtiar et al., 2019; Dintoro et al., 2020). The sensor MQ-6 is a gas detector that is used to identify butane, propane, and liquid petroleum gas (LPG). This sensor is frequently used in gas-related areas of traditional homes like the kitchen. MQ-6 is highly sensitive to the type of gas in question and is helpful in identifying gases that could cause a explosion (Fachrureza et al., 2021).

The MQ-7 sensor type is used to detect atmospheric carbon monoxide (CO). Carbon monoxide is a non-combustible poison gas, so this sensor is very important for monitoring CO levels in areas with potential exposure, such as parking rooms, and heating rooms. (Ardiansyah et al., 2018). The Sensor MQ-9 is a sensor that can detect flammable gases like carbon monoxide (CO) and easily combustible gases like methane (CH₄). This sensor is frequently used in a system for monitoring and protecting the environment to detect the presence of dangerous fires or exposure to harmful (Gunawan et al., 2019). The Sensor MQ-135 is a gas sensor that is capable of detecting a variety of gases, including ammonia (NH₃), nitric oxide (NO_x), benzene, aseton, and

other uranium compounds. This sensor is frequently used in applications for high-quality ceiling fans in rooms, or industrial gas detection equipment (Zulni, 2015).

As a relative humidity and temperature detector, the sensor DHT11, which is frequently used in a variety of applications, such as climate control, surrounding monitoring systems, and soil humidity measurement. This sensor provides accurate and reliable data with quick response times (Fathulrohman & Saepuloh, 2018). The oxygen detector is KE-50 sensor. The sensor in question is both air and corrosion resistant. This sensor is frequently used in industrial and environmental applications that require accurate and reliable measuring temperature (Ekawati et al., 2017). The sensor OCS-3F is an optical sensor that is used to detect objects or barrier in short distance. This sensor is frequently used in movement detection systems, distance calculation, and artificial intelligence app (Kuspranoto et al., 2022). Additionally, BMP-180 sensor is an atmospheric and water vapor sensor that is frequently used in weather, navigation, and land survey applications. With a small area and high daytime energy consumption, this sensor provides accurate data on the atmosphere and humidity (Amaluddin & Haryoko, 2019).

According to recently completed literature, there are oxygen sensors that can be used to build systems for oxygen gas monitoring system. Sensors MQ-135 and KE-50 are two examples of sensors used as detector oxygen gas. As an oxygen sensor, the KE-50 is frequently used in medical devices like anesthesia machines and respirators. In addition to that, it is used to detect oxygen in air conditioners and detect oxygen when a fire breaks out (Ekawati et al., 2017). The KE-50 sensor's characteristics include long-lasting battery life, stable output signal, no need for external power polish for sensor operation, and no need for heating time. But the price of the KE-50 sensor is somewhat out of line. In addition, sensor MQ-135 is another device that can detect oxygen (O₂). In addition to this, the sensor MQ-135 can detect other gases in the atmosphere, including ammonia (NH₃), nitrium oxide (NO_x), etanol (C₂H₅OH), benzene (C₆H₆), carbon dioxide (CO₂), hydrogen sulfide (H₂S), and other gases (Zulni, 2015). Sensor MQ-135 has a competitive price and is easy to obtain, making it more relevant when being used.

Brain is required as the sensors trigger while running the sensors in question, such as a microcomputer, microcontroller, or microprocessor. According to the review that was already completed, it used the Raspberry Pi, Arduino Uno, Microcontroller ATmega8535, and Nodemcu ESP8266. The Raspberry Pi has a two-pin input/output. At the same time, the Raspberry Pi clock runs at 1,4 GHz, which is 40 times faster than the Arduino. As a result of the lack of a capacity for the card, Micro-SD was used for the uploading process. The Raspberry Pi can run on the Linux operating system. Linux is often criticized for being able to launch more complex systems. But because of the limited number of hard drives, the problem requires further augmentation of the device. ARM is used in the Raspberry Pi processor. Python has been recommended by Raspberry Pi as a programming language. But at this time, C, C++, and Ruby had already been installed. Raspberry Pi's capacity and device are rising. Prices are definitely rising. With these incredibly specific specifications, Raspberry Pi is used as an essential component that connects to the MQ-135 sensor (Ankush & Patil, 2017; Besari, 2019; Kamble et al., 2022; Kumar & Jasuja, 2017).

The microcontroller Arduino is capable of running the same program repeatedly. Its use is found by many simple components, ranging from gates, data transmitters, in the manufacture of temperature sensors. Arduino has 20 pin input and output, and its memory board has a 32 KB capacity. In addition, external peripherals like WiFi, Ethernet, a sentry line, a camera, and other devices are connected. Arduino installation is done by pasting it into a flash drive. Arduino uses the AVR Atmega328P processor. The Arduino program starts when the power is turned on, and when the power is turned off, the program begins to run briefly. Arduino uses C/C++ that is designed to be a programming language. This makes it extremely suitable for students, teachers, and thesis. Additionally, the price is quite reasonable and easy to negotiate (Gunawan et al., 2019; Lowongan et al., 2015).

The most popular microcontroller manufactured by Microchip Technology (formerly known as Atmel Corporation) is the ATmega8535. This particular microcontroller is frequently used in a variety of electronic projects and programming systems. Microcontroller ATmega8535 uses the RISC architecture with the AVR (Advanced Virtual RISC) instruction set. This makes quick and efficient instruction execution possible. This microcontroller has an 8-bit integer CPU with a 0–16 MHz clock speed, enabling quick data processing. ATmega8535 has an inbuilt memory that is sufficiently large for most applications. Flash memory has an 8KB capacity that can be used to store program code. In addition to that, there are also 512B RAM and 512B EEPROMs for data storage. This microcontroller has GPIO pins that may be configured as inputs or outputs, enabling users to communicate with external devices including sensors, actuators, and other devices. The ATmega8535 uses USART (Universal Synchronous/Asynchronous Receiver/Transmitter) for serial

communication, enabling serial data exchange with other devices including sensors, jarring modules, and other devices. This microcontroller features several timer/counters that can be used to measure actual time, set frequency, and adjust system operation speed. This microcontroller supports SPI communication, enabling interaction with a variety of devices such as sensors, display modules, and other external ICs (Rasyidi, 2011).

NodeMCU ESP8266 is used only in the development of Internet of Things projects like monitoring the environment, pinging data sensors, and many others. NodeMCU ESP8266 is a popular and simple platform that may be used in the development of IoT applications due to its combination of WiFi capability, small size, and strong community connections. The ESP8266 chip is used by NodeMCU as its primary microcontroller. ESP8266 has an internal Tensilica Xtensa LX106 with a speed of up to 80 MHz and external RAM. The integrated WiFi capabilities of the ESP8266 enable device to connect to WiFi networks and communicate with other devices using the TCP/IP protocol. This enables the development of IoT applications that are connected to the internet. The NodeMCU ESP8266 comes with GPIO pins that can be used as inputs or outputs. NodeMCU ESP8266 has a USB armour that simplifies programming and debugging. In addition to this, it has pins for UART, I2C, SPI, PWM, and ADC that can be used for a variety of communications with external devices and interactions with them (Fachrureza et al., 2021; Manullang et al., 2021; Rochmania et al., 2021).

From a few of these components, installing the Raspberry Pi is a very easy process because, compared to Arduino, it has a higher computing power. The Raspberry Pi is a single-board computer with a powerful processor, plenty of RAM, and a comprehensive operating system. This makes it possible for Raspberry Pi to run more complex applications and handle data with faster processing speeds. Raspberry Pi comes with a variety of connectivity options, including Ethernet, Wi-Fi, and Bluetooth. This simplifies integration with local networking, access to the internet, and communication with other devices. Connectivity that is strong and easy to use is a crucial element of an IoT project. In this situation, Raspberry Pi significantly hinders the project that will be carried out when the monitoring oxygen rate is done using internet of things (IoT).

CONCLUSION

The process of making cement generally goes through five stages, namely raw material storage, raw material grinding, burning, final grinding, and packaging. The process will produce exhaust gases consisting of several gas components. The most important gas component is oxygen (O₂) because it is a crucial gas for human life. Therefore, innovation regarding gas analyzers is needed. Gas analyzers are designed with the working principle of taking gas samples through a probe then going to each sample cell. The sample gas will be compared with standard gas through a transmitting system that will produce a wavelength difference and be converted into analog signals and receivers. The development of science and technology has made more and more new discoveries, one of which is the innovation of gas analyzer devices through sensors and main devices. Therefore, this literature review is useful for specifying sensors used as oxygen detectors. Based on the tour that has been carried out, the MQ-135 sensor was chosen as an oxygen sensor supported by a microprocessor in the form of a Raspberry Pi. Thus, the use of these two components is expected to work together as a means of monitoring oxygen gas content.

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