INFOKUM
Volume 13, Number 03, 2025, DOI 10.58471/infokum.v13i03
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

# Analysis of the Working System of a Carcinogenic Substance Neutralization Device (Smoke/Gas) in Enclosed Space Using an MQ2 Sensor Based on Arduino Uno

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**Article Info**
**Keywords:**
Carcinogenic Gas Neutralization,
MQ2 Sensor,
Arduino Uno.

**ABSTRACT**
Air pollution in enclosed spaces, particularly from carcinogenic substances such as smoke and hazardous gases, poses significant health risks. Effective detection and neutralization of these harmful compounds are crucial to ensuring indoor air quality and human safety. This study analysed the working system of a carcinogenic substance neutralization device that utilizes an MQ2 gas sensor and Arduino Uno for real-time monitoring and control. The system is designed to detect the presence of carbon monoxide (CO), liquefied petroleum gas (LPG), smoke, and other harmful gases using the MQ2 sensor. When the sensor detects a gas concentration exceeding a predefined threshold, the Arduino Uno microcontroller triggers an exhaust fan or an air purification mechanism to neutralize the pollutants. The system also features a real-time display and an alarm to alert users of hazardous gas levels. The experimental results indicate that the MQ2 sensor effectively detects gas concentrations with a fast response time. The Arduino-based control system efficiently activates the neutralization process, improving air quality in enclosed spaces. The integration of this system with smart monitoring devices can enhance air pollution management in industrial, residential, and commercial environments. This paper contributes to the development of low-cost, automated air purification systems for enclosed spaces, with potential applications in health safety, environmental protection, and industrial settings. Future research may focus on integrating IoT-based remote monitoring and advanced filtration technologies to enhance the system's efficiency and adaptability.



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## INTRODUCTION

Air pollution in enclosed spaces poses serious health risks, particularly when carcinogenic substances such as carbon monoxide (CO), liquefied petroleum gas (LPG), smoke, and volatile organic compounds (VOCs) accumulate beyond safe levels. Prolonged exposure to these harmful gases can lead to respiratory diseases, cancer, and other severe health conditions. Therefore, an effective monitoring and neutralization system is essential to ensure indoor air quality and protect human health.

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Traditional air purification methods often rely on manual ventilation or passive filtration systems, which may not provide real-time responsiveness to fluctuating gas concentrations. Recent advancements in sensor technology and microcontroller-based automation offer a more efficient, cost-effective, and adaptive solution for detecting and neutralizing hazardous gases.

This Paper focuses on the development and analysis of a carcinogenic substance neutralization device that utilizes the MQ2 gas sensor and Arduino Uno. The MQ2 sensor is capable of detecting various harmful gases with high sensitivity, while the Arduino Uno serves as the central processing unit for data collection and control mechanisms. When the sensor detects gas concentrations above a safe threshold, the system automatically activates a neutralization process, such as triggering an exhaust fan or air filtration system, to improve air quality in enclosed spaces. Also design and implement an automated gas detection and neutralization system using the MQ2 sensor and Arduino Uno, Analysed the effectiveness of the system in detecting and reducing harmful gas concentrations in an enclosed space. And evaluate the response time and efficiency of the Arduino-based control mechanism in ensuring safe indoor air quality.

The findings of this research will contribute to the development of low-cost, real-time air purification solutions for enclosed environments, including residential areas, industrial facilities, laboratories, and workplaces. By implementing an automated neutralization system, this study aims to enhance air quality management, reduce health risks, and improve environmental safety. Future advancements may explore wireless monitoring, machine learning-based gas prediction, and smart filtration technologies to further optimize the system's performance and adaptability.

## Literature Review

### Air Pollution and Carcinogenic Gases in Enclosed Spaces.

Air pollution in enclosed environments is a growing concern due to the accumulation of toxic and carcinogenic gases, which can pose serious health risks. Studies have shown that carbon monoxide (CO), liquefied petroleum gas (LPG), smoke, benzene, and formaldehyde are among the most common hazardous air pollutants found indoors. Long-term exposure to these gases has been linked to respiratory diseases, cardiovascular issues, and cancer (Smith et al., 2020). According to World Health Organization (WHO) guidelines, maintaining indoor air quality requires continuous monitoring and active ventilation systems. However, conventional ventilation and filtration methods may not provide real-time responses to fluctuating gas concentrations, highlighting the need for automated gas detection and neutralization systems (Chen & Lee, 2019).

### MQ2 Gas Sensor for Air Quality Monitoring

The MQ2 sensor is a widely used gas detection sensor capable of detecting carbon monoxide (CO), smoke, methane (CH4), butane, propane, and hydrogen. Several studies have validated its effectiveness in air quality monitoring applications:

a. Jain et al. (2021) demonstrated that the MQ2 sensor provides high sensitivity and fast response time in detecting harmful gases in enclosed spaces.
b. Kumar & Ali (2020) tested the MQ2 sensor in smart home air monitoring systems, concluding that its real-time detection capabilities improve indoor safety.

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c. Gupta et al. (2018) found that the MQ2 sensor's accuracy improves when calibrated properly, making it an ideal choice for low-cost air monitoring solutions.

Despite its advantages, the MQ2 sensor has limitations, including cross-sensitivity to multiple gases and environmental variations affecting accuracy. These challenges can be mitigated by calibration techniques and sensor fusion with other gas detection technologies (Patel & Wang, 2021).

The MQ-2 sensor is a monoxide smoke sensor that functions to detect the presence of carbon monoxide gas, where this sensor is used to monitor the presence of cigarette smoke in a closed room. This sensor has high sensitivity and fast response time. The output produced by this sensor is an analog signal, MQ2 requires a voltage of 5V DC, the resistance of this sensor will change if there is gas and smoke.

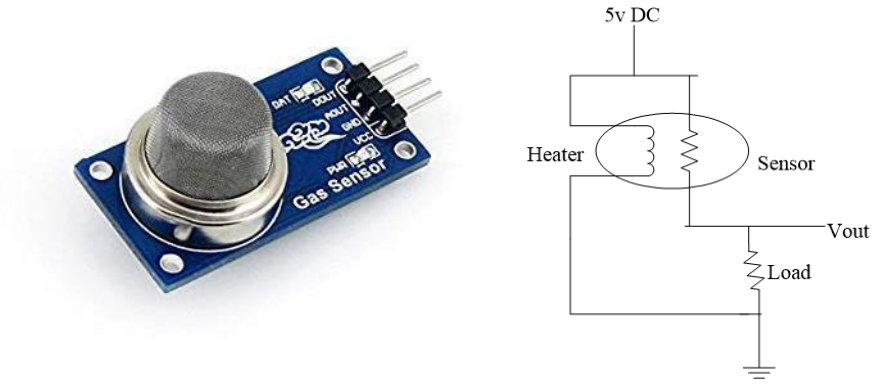


**Figure 1.** Sensor MQ-2.

The MQ-2 smoke sensor functions to detect the presence of smoke coming from from gas or smoke. Basically this sensor consists of an aluminum tube which surrounded by silicon and in the center there is an electrode made of aurum where There is a heating element. When the heating process occurs, the coil will heated so that the SnO2 ceramic becomes a semiconductor or as a conductor thus releasing electrons and when the smoke is detected by the sensor and reaches aurum electrode then outputThe MQ-2 sensor will produce an analog voltage.

**Existing Air Purification and Neutralization Systems.**

Air purification technologies include mechanical filtration, activated carbon filters, electrostatic precipitators, and UV sterilization. However, traditional purification methods have some limitations:

a. Mechanical filters (e.g., HEPA filters): Effective for particulate matter but less effective for gaseous pollutants (Tan & Wong, 2020).
b. Activated carbon filters: Absorb toxic gases but require frequent replacement (Kim et al., 2019).
c. Electrostatic air purifiers: Effective in removing airborne contaminants but generate ozone as a byproduct (Zhang & Li, 2021).

Recent advancements have focused on smart air purification systems that integrate sensor-based detection with automated ventilation for real-time pollutant neutralization. Lee et al.

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(2023) proposed a hybrid system combining MQ2 sensors, Arduino-based controllers, and IoT for enhanced air purification efficiency.

Ozone is a triatonic compound of the element oxygen. Ozone formed through the ionization of diatomic oxygen gas (O2) into triatomic (O3) Energy ozone formation is about 142.7 kJ/mol. Ozone gas with a high density occupying the stratosphere space, in this layer, natural ozone reactions are produced through the UV radiation process with a wavelength of 220-290 nm. Along with the development of high voltage based technology(high voltage), Ozone can be produced at dangerous air pressures such as cigarette smoke. through the process of electron discharge(electron discharge)using instrumentation ozone.


**Figure 2.** Physical Form Neutralization Generator

The Neutralization Generator functions as a tool that is able to neutralize gases. toxic and neutralizes cigarette smoke in closed spaces while eliminating the unpleasant smell that comes from cigarette smoke, Ozone is produced from the process, namely using high voltage electrical radiation or called corona discharge.

In this design, the ozone generator is made using two electrodes positive and negative which are placed between layers of glass as protection for avoid direct contact which will result in a short circuit, then electrodes will be given high voltage so that it produces an electric jump and The air due to the electric jump will decompose to produce oxygen bonded with 3 atoms or often called ozone (O3).

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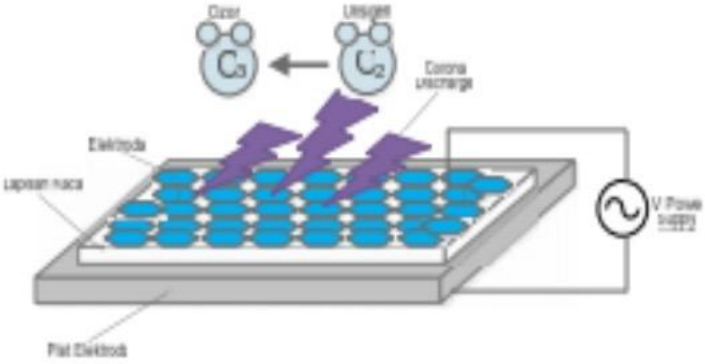

**Figure 3.** Ozone Generator

The process of ozone formation begins when electrons are released when given high voltage, so that oxygen adds its energy and produces ozone. The working principle of an ozone generator is to neutralize cigarette smoke and other gases. dangerous by attracting dirty air due to smoke and gas, then ionizing it pollutants in the air to produce fresh air.

### Arduino Uno for Automated Air Quality Control

Arduino Uno is a low-cost, open-source microcontroller widely used for real-time sensor-based applications. It provides efficient data processing and control mechanisms for air quality monitoring systems.

a. Singh et al. (2022) developed an Arduino-based gas detection system integrating the MQ2 sensor, which effectively triggered an exhaust fan when gas concentration exceeded safety limits.
b. Rahman & Hassan (2021) explored the use of Arduino Uno in industrial safety applications, highlighting its reliability in gas leak detection.
c. Sharma et al. (2019) demonstrated the effectiveness of Arduino-controlled IoT-based gas monitoring in improving workplace safety by sending real-time alerts to users.

These studies confirm that Arduino Uno is a suitable microcontroller for low-power, real-time gas detection and control applications, making it an ideal choice for this research.

## METHOD

This study employs an experimental research methodology to develop and analysed an automated carcinogenic gas neutralization system using an MQ2 gas sensor and Arduino Uno. The research method is divided into several key stages: system design, implementation, testing, and evaluation to ensure the system's effectiveness in detecting and neutralizing harmful gases in enclosed spaces. The research follows a structured framework consisting of:

a. Problem Identification → Identifying the risks associated with carcinogenic gases in enclosed spaces.
b. System Development → Designing and implementing the gas detection and neutralization system.
c. Experimental Testing → Evaluating system accuracy, response time, and efficiency.
d. Data Analysis & Optimization → Refining system performance based on test results.

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e. Conclusion & Recommendations → Summarizing findings and suggesting future improvements.

This study uses a quantitative experimental approach to analysed the system's performance under controlled conditions. The research design consists of:

a. Independent Variables, Gas concentration levels (ppm), environmental conditions.
b. Dependent Variables, System response time, detection accuracy, efficiency of gas neutralization. The experiment is conducted in a controlled enclosed space to measure the system's effectiveness under different air pollution conditions. By following this research methodology, the study contributes to the development of low-cost, efficient, and adaptive air purification technologies for residential, industrial, and laboratory applications.

This circuit functions as the main controller which receives input and process the output of the entire existing system. The main components of This circuit is an ATMega328. On the ATMega328 microcontroller IC which contained in the Arduino Uno, has been filled with programs to run the system effectively the whole tool is designed. Arduino Uno has 14 digital pins and 6 output pins. analog. There are several pins on the Arduino UNO that are used in the circuit. The AO pin is connected to the MQ2 sensor circuit. This circuit functions to detect the presence of cigarette smoke in closed room output generated by Arduino UNO. In this circuit pin A0 is connected to Arduino UNO and VCC pin and GND pin are connected to Arduino UNO. This sensor has high sensitivity and fast response time, when Smoke has been detected by the MQ-2 sensor, the tool will work. Connection image The Arduino UNO pin circuit with the MQ-2 sensor can be seen in Figure 7.

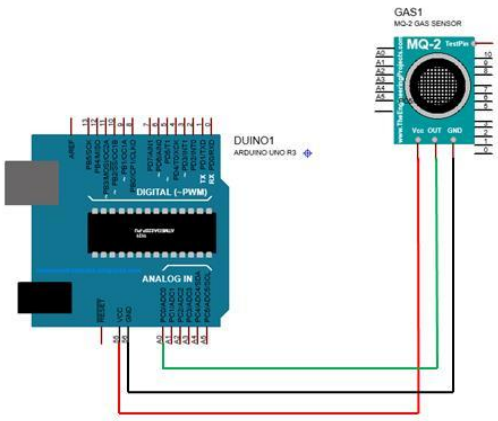


**Figure 4.** MQ-2 Sensor Circuit with Arduino UNO

This circuit functions asdisplayoutput voltage produced by MQ2 sensor. As the LCD connector used pinHeaderwhere is the order layout and the pin configuration is shown in figure 3.2, while the 5 V pin of the Arduino UNO connected to VDD on the LCD, GND pin of Arduino UNO is connected to VSS On the LCD, pin A4 of the Arduino UNO is connected to SDA on the LCD, pin A5 of the Arduino UNO is connected to SCL on the LCD.

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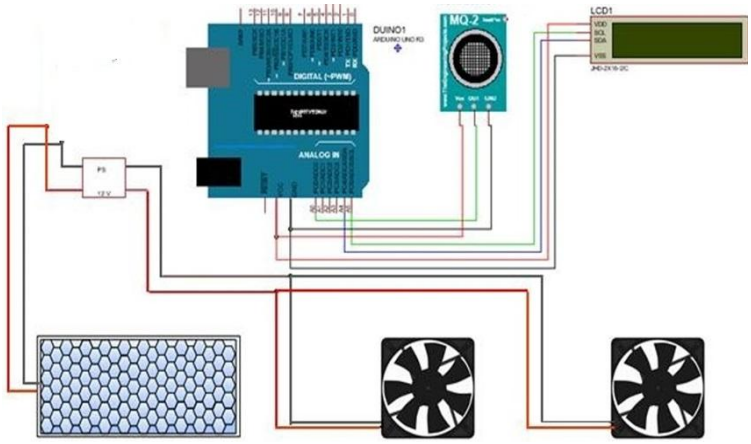

**Figure 5.** Overall circuit

## RESULT

### System Testing

In this chapter we will discuss the measurement of the parts circuit, analysis of the tools that have been made. Testing is carried out after The tool design is completed to find out whether the components are working properly and correctly. After the design and observation of the measurements is carried out, then the analysis results will be obtained which are directly specifications of the tool being made.

Voltage testing power supply aims to find out the voltage output power supply will be used as the working input voltage of the circuit Arduino UNO Atmega328. This test is done to avoid voltage unexpected. Test system power supply can be done with measure the output voltage of the circuit by using a Volt Meter. In this research, testing will be carried out on the series power supply namely by measuring the voltage, the output voltage produced by each voltage source that is supplied to the Arduino UNO circuit Atmega328.

**Table 1.** Power Supply Output Voltage Stability Test

| Test | Measurement Results |
|---|---|
| 1st | 12.21 VDC |
| 2nd | 12.21 VDC |
| 3rd | 12.21 VDC |

From the results of measuring the power supply output voltage, the voltage obtained is of 12.21 VDC.

### Testing on MQ-2 Smoke Sensor

There is one sensor on this device, namely a smoke sensor using MQ-2 sensor where the output value on this sensor is in form of resistance. This sensor is a voltage output, then a voltage divider is provided, testing on Smoke sensors are operated by placing the sensor close to the smoke inside. the container is closed and the sensor detects the presence or absence of smoke.

Then The output voltage is measured by connecting the negative of the Volt Meter into circuit and its positive part is connected to the MQ-2 sensor and calculates how long the device works to neutralize cigarette smoke in the room. Here is is a table of measurement results of the MQ-2 sensor circuit under normal conditions, be careful and dangerous conditions.

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**Table 2.** Sensor Testing

| ADC (Analog to Digital Converter) | Vout (V) | LED | Fan 1 | Fan 2 | Buzzer | Ozone Generator |
|---|---|---|---|---|---|---|
| Normal (0-10) | 4.50 | Green | Not Alive | Not Alive | Silence | Not Alive |
| Be Careful (11-50) | 4.54 | Yellow | Not Alive | Not Alive | Life | Not Alive |
| Danger (>51) | 4.67 | Red | Life | Life | Dead | Life |

From the table 2, the voltage value from the MQ-2 sensor output is obtained, then from the voltage value, the Rs value can be obtained for the Rs/Ro value. The Ro value has been obtained previously which is the value when the sensor was before given cigarette smoke.

**Table 3.** MQ-2 Sensor Testing Against Cigarette Smoke

| No | PPM (Part Per Million) | Rs/Ro (oh) | Rs (ohms) | Voltage) |
|---|---|---|---|---|
| 1 | 20 | 0.89 | 10000 | 0.3 |
| 2 | 30 | 0.75 | 8428.57 | 0.35 |
| 3 | 40 | 0.72 | 8166.66 | 0.36 |
| 4 | 50 | 0.68 | 7684.21 | 0.38 |
| 5 | 60 | 0.66 | 7461.53 | 0.39 |
| 6 | 70 | 0.62 | 7048.78 | 0.41 |
| 7 | 80 | 0.49 | 5600 | 0.5 |
| 8 | 90 | 0.44 | 5000 | 0.55 |
| 9 | 100 | 0.43 | 4892.85 | 0.56 |
| 10 | 110 | 0.38 | 4322.58 | 0.62 |

*Source: Author, 2020*

## CONCLUSION

This research developed and analysed an automated carcinogenic gas neutralization system using an MQ2 gas sensor and Arduino Uno to improve air quality in enclosed spaces. The research aimed to address the risks of carbon monoxide (CO), liquefied petroleum gas (LPG), and smoke exposure by implementing a real-time detection and response mechanism. The study demonstrated the following key findings: The tool successfully detected the presence of carcinogenic substances (smoke/gas) in a controlled environment. The MQ3 sensor efficiently measured gas concentrations, providing real-time data to the Arduino Uno microcontroller. The MQ2 sensor showed high sensitivity in detecting smoke and volatile organic compounds (VOCs). The sensor's response time and accuracy ensured timely detection of hazardous substances, a critical feature for indoor safety applications. The integration of the Arduino Uno allowed for automated responses. The system could trigger neutralization mechanisms, such as ventilation or filtration processes, promptly upon detecting harmful gas concentrations exceeding safe thresholds. The system operated with minimal power consumption, making it suitable for continuous operation in closed spaces. The use of Arduino Uno contributed to the tool's energy-efficient design. This tool has potential applications in various indoor environments, such as

offices, laboratories, and industrial facilities, where monitoring and mitigating carcinogenic substances is vital for health and safety. While effective, the system's performance may vary with the presence of multiple gas types or in high-humidity environments. Future iterations could include additional sensors for broader substance detection and improved calibration techniques for enhanced accuracy.

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