

# Gas Leakage Detecting and Alerting System using IoT

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**Abstract** - Hazardous gas leakage occurs in the Oil and Gas Industry and may lead to various environmental effects. This project presents a cost-effective and reliable Internet of Things (IoT) system for detecting gas leaks and promptly alerting occupants and authorities. Our system “Gas explosion detecting and alerting system using IoT” aims to detect the hazardous gas leakage and alert the workers and company management. We have integrated IoT (Internet of Things) and GSM (Global System for Mobile Communication) to send SMS messages conveying the critical situation to the corresponding workers and management. This project uses MQ135 gas leakage detection sensors to detect hazardous gases like NH<sub>3</sub>(ammonia), sulphur, Benzene, CO<sub>2</sub>, Smoke and other harmful gases. This sensor is connected with Arduino NANO. When the sensor detects leakage of gas, the arduino will activate the alarm buzzer to alert the workers. Additionally, a red LED illuminates to provide a visual confirmation of the gas leak. and the Arduino is interfaced with GSM module to send alert messages to the management of the company.

**Keywords:** *MQ135 Sensor, Arduino NANO, GSM, SIM card, LCD Display.*

## **1.Introduction-**

Gas explosions are a persistent concern in residential and industrial settings. Natural gas leaks can be extremely hazardous, leading to devastating consequences if left undetected. To address this challenge, this project proposes an IoT-based gas explosion detection and alerting system that employs readily available components to create a robust and cost-effective solution. Our project presents an innovative, IoT-based gas explosion detection and alerting system. By harnessing the capabilities of readily available components, this

system provides a cost-effective and robust solution for safeguarding homes, businesses, and industrial facilities. This response goes beyond simply detecting a leak; it offers a multi-layered approach by alerting by means of alert messages. This MQ-135 gas sensor module, sensor is specifically designed to identify combustible gases like methane, NH<sub>3</sub>, Sulphur dioxide, Carbon monoxide and common smoke and some primary components of natural gas. As the gas concentration increases, the MQ-135's electrical resistance changes, sending a clear signal to the Arduino NANO microcontroller. The GSM shield, another key component, allows the system to connect to a cellular network using a SIM card. This connectivity enables the system to send SMS alerts to pre-programmed phone numbers. These phone numbers can be designated for individuals within the building, such as a building manager, or emergency services personnel, ensuring a response to the gas leak. With an optional LCD display, the system can showcase real-time gas concentration readings, allowing users to monitor gas levels and assess the severity of the leak.

[1]. The paper “Energy-Efficient routing protocol for reliable low-latency internet of Things in oil and gas pipeline monitoring” proposed by KaramSN, Bila K and others published in 2024 says that the oil and gas industries (OGI) are the primary global energy source, with pipelines as vital components for OGI transportation. However, pipeline leaks pose significant risks, including fires, injuries, environmental harm, and property damage. The Internet of Things (IoT) has emerged as a cutting-edge technology for efficient OGI pipeline leak detection. (Karam et al. 2024)

[2]. The project “Evaluating a novel gas sensor for ambient monitoring in automated life science laboratories” by MFR, Roddelkopf T and others published in the 2022 says that Air pollution and leakages of hazardous and toxic gases and chemicals are among the dangers that frequently occur at automated chemical and life science laboratories. In this study, a commercial MOX gas sensor, SGP41, was embedded in an IoT environmental sensor node for hazardous gas detection and alarm. (Al-Okby et al. 2022)

[3]. The project “Modelling and implementation of a low-cost IoT-smart weather monitoring station and air quality assessment based on fuzzy inference model and MQTT protocol” by Fahim M, El Mhouthi A and others published in 2023 says that with the advancement of smart technologies, the system has evolved into many sensing methods to gather real-time climate data. This article investigates the modelling and implementation of a low-cost weather station device that also functions to measure air quality. The proposed system based on the Internet of Things (IoT) allows access to real-time climate data for a given area. It uses MQ135 sensor and other things to provide the data related to the weather. (Fahim et al. 2023)

[4]. The project “Enhancing data transmission in duct air quality monitoring using mesh network strategy for LoRa” by Mulick A, Abd Rahman AH and others published in 2023 says that Duct air quality monitoring (DAQM) is a typical process for building controls, with multiple infections outbreaks reported over time linked with duct system defilement. A mobile LoRa-based data collection technique is implemented for various data sensors such as DHT22, MQ7, MQ2, MQ135, and DSM50A to identify carbon monoxide, carbon dioxide, smoke, and PM2.5 levels.(Mullick et al. 2022)

[5]. “Quantifying non-steady state natural gas leakage from the pipelines using an innovative sensor network and model for subsurface emissions – InSENSE” by Lo JH ,smits KM and others published in 2024 jan says that Detecting and quantifying subsurface leaks remains a challenge due to the complex nature and extent of belowground leak scenarios. To address these scenarios, monitoring and evaluating changes in gas leakage behaviour over space and time are crucial for ensuring safe and efficient responses to known or potential gas leaks. This study demonstrates the capability of linking environmental and gas concentration data obtained using a low-cost, near real-time methane (CH<sub>4</sub>) detector network and an inverse gas migration model to capture and quantify non-steady state belowground natural gas (NG) leaks.(Lo et al. 2024)

[6]. The project “High-resolution geoelectrical characterization and monitoring of natural fluids emission systems to understand possible gas leakages from geological carbon storage reservoirs” by salone R,De Paola and others published in the year 2023 says that Gas leakage from deep geologic storage formations to the Earth's surface is one of the main hazards in geological carbon sequestration and storage. In this framework, we propose a combined use of high-resolution geoelectrical investigations (i.e. resistivity tomography and self-potential surveys) for reconstructing shallow buried fracture networks in the caprock and detecting preferential gas migration pathways before it enters the atmosphere. (Salone et al. 2023)

[7]. “A novel benzo hemicyanine-based fluorescent probe for susceptible visualising detection of phosgene” by Shao S,Bao C and others published in 2023 says that Leakage and misuse of phosgene, a common and highly hazardous industrial chemical, have always constituted a safety risk. Therefore, it is crucial to develop sensitive detection methods for gaseous phosgene. This work describes the design and development of a new fluorescent dye based on benzo hemicyanine, as well as the synthesis of fluorescent probes for the sensitive detection of gaseous phosgene.(Shao et al. 2023)

[8]. “Characterization of H<sub>2</sub>S QEPAS detection in methane-based gas leaks dispersed into environment” by Olivieri M,Menduni G and others published in the year 2023 says that the increase in fatal accidents and chronic illnesses caused by hydrogen sulphide (H<sub>2</sub>S)

exposure occurring in various workplaces is pushing the development of sensing systems for continuous and in-field monitoring of this hazardous gas. We report here on the design and realisation of a Near-IR quartz-enhanced photoacoustic sensor (QEPAS) for H<sub>2</sub>S leaks detection. H<sub>2</sub>S QEPAS signal was measured in matrices containing up to 1 % of methane (CH<sub>4</sub>) and nitrogen (N<sub>2</sub>) which were chosen as the laboratory model environment for leakages from oil and gas wells or various industrial processes where H<sub>2</sub>S and CH<sub>4</sub> can leak simultaneously. (Olivieri et al. 2023)

[9]. “Evaluating of IAQ-Index and TVOC Parameter-Based Sensors for Hazardous Gases Detection and Alarming Systems” by Al-okby , Neubert S and others published in the year 2021 says that The measurement of air quality parameters for indoor environments is of increasing importance to provide sufficient safety conditions for workers, especially in places including dangerous chemicals and materials such as laboratories, factories, and industrial locations. n this paper, the IAQ-index and TVOCs have been investigated to identify the best and most flexible solution for air quality threshold selection of hazardous/toxic gases detection and alarming systems.(Al-Okby et al. 2022)

[10]. “Mobile Detection and Alarming Systems for Hazardous Gases and Volatile Chemicals in Laboratories and Industrial Locations” by Al-okby, Neubert S published in the year 2021 says that The leakage of hazardous gases and chemical vapors is considered one of the dangerous accidents that can occur in laboratories, workshops, warehouses, and industrial sites that use or store these substances. The early detection and alarming of hazardous gases and volatile chemicals are significant to keep the safety conditions for the people and life forms who work in and live around these places. (Al-Okby et al. 2021).

## ***2.Materials required -***

### ***Hardware requirements-***

- MQ135 gas detection sensor module
- Arduino NANO
- GSM Shield
- SIM card
- LED light
- Buzzer or alarm

### ***Software Requirements***

- Arduino IDE
- Google Chrome or any browser

### ***3. Approach***

#### ***3.1 MQ135 Sensor***

MQ135 is a sensor that detects gas like NH<sub>3</sub>, Sulphur dioxide, carbon monoxide, methane and smoke etc. This sensor is used to detect gas leakage. It works with the principle of resistance changes in response to the presence of different gases. To use this sensor, we should connect it to a microcontroller. The pins A0, GND, VCC are the main pins that should be connected to the microcontroller.

#### ***3.2 Arduino NANO***

Arduino NANO is a microcontroller. The Arduino nano is one of the most popular and widely used development boards in the Arduino ecosystem. It is based on the ATmega328 microcontroller and provides a simple and easy-to-use platform for building electronic projects, prototyping, and learning about electronics and programming.

#### ***3.3 GSM Shield***

GSM 900A Global System for Mobile communication module with 900 Hz frequency is used to send messages to the connected mobile. It is commonly used in various applications that require cellular communication capabilities, such as IoT (Internet of Things) devices, remote monitoring systems, tracking systems, and communication modules for embedded systems. In our project, GSM is connected with the microcontroller Arduino NANO in order to send alert messages.

#### ***3.4 SIM Card***

A SIM card, or Subscriber Identity Module card, is a small electronic chip that is used in mobile phones and other cellular-enabled devices to identify and authenticate users on a mobile network. This SIM card is inserted in the GSM Module to send messages to the respected person or a management.

#### ***3.5 LED***

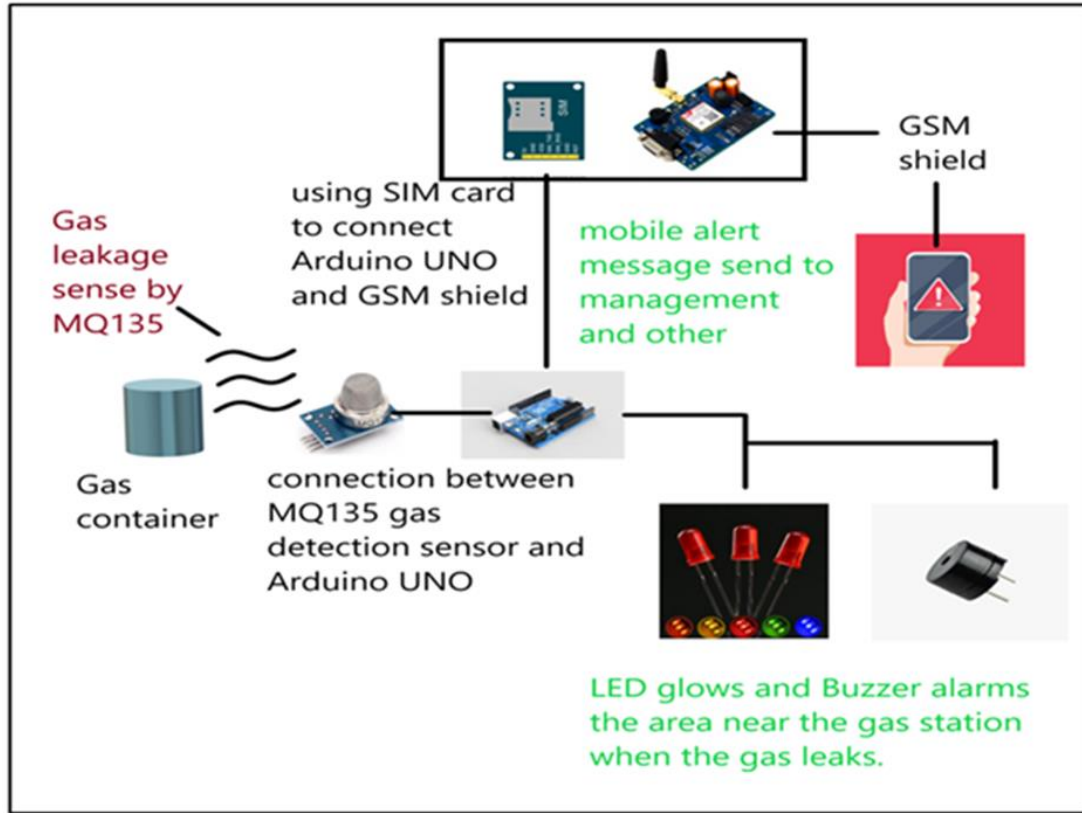
A Light Emitting Diode (LED) is a semiconductor device, which can emit light when an electric current passes through it. To do this, holes from p-type semiconductors recombine with electrons from n-type semiconductors to produce light.

#### ***4. Proposed System-***

The MQ135 sensor is connected with Arduino NANO and placed near the gas container(that is., where the hazardous gas is stored.Arduino NANO is connected with a GSM shield using a SIM card to send alert messages.Further the Arduino NANO is connected with LED and Buzzer to alarm the worker in that corresponding place.When the sensor detects the gas leakage, the LED glows and Buzzer (alarm) alerts the workers and alert message is sent to the management quickly through the GSM shield.the advantages of proposed system are Remote Notification: The integration of GSM technology allows the system to send SMS alerts to management and workers, ensuring that alerts are received promptly even if they are not on-site.Local Alerts: The system includes both LED indicators and buzzers to provide immediate visual and audible alerts to workers in the vicinity of the gas leak.Continuous Monitoring: The system continuously monitors gas levels, ensuring that any leaks are detected as soon as they occur.Easily Scalable: The system can be scaled to cover larger areas or additional locations within a facility, making it adaptable to various sizes and types of facilities.Customizable: The system can be customised to meet specific industry needs, allowing for tailored solutions based on the particular gases and risks present.

#### ***5. System Architecture-***

In the development of a cost-effective and reliable Internet of Things (IoT)-based system for detecting gas leaks and promptly alerting occupants and authorities. By leveraging the capabilities of readily available components, this system provides a multi-layered approach to mitigating the risks associated with gas explosions in homes, businesses, and industrial facilities. Wiring the MQ-135 sensor to the Arduino sensor's datasheet specifications. Typically, the sensor's analog output connects to an analog pin on the Arduino. Also, connect the GSM shield to the Arduino. Integrate the LED with a current-limiting resistor and connect it to a digital pin on the Arduino. Connect the buzzer or alarm directly to the Arduino or via a transistor for driving higher currents. An LCD display is connected using an I2C interface or SPI communication depending on the display's requirements. In the Arduino IDE the code is integrated such that the code will initialise communication with the MQ-135 sensor and potentially calibrate it for optimal accuracy. Set up the GSM shield and configure the SIM card for SMS message transmission. Define a threshold gas concentration level that triggers the alert system. Continuously read data from the MQ-135 sensor. Compare the sensor readings with the threshold. If the threshold is exceeded, activate the buzzer or alarm to generate an audible alert. Turn on the red LED for a visual indication. Utilise the GSM shield to send an SMS alert to predefined phone numbers notifying them of a gas leak. The system operates continuously, providing real-time gas leak detection and alerting capabilities. The Arduino constantly reads data from the MQ-135 sensor. The sensor output, an analog voltage, corresponds to the gas concentration in the surrounding air. The Arduino code compares the sensor readings with a predefined threshold value. This threshold represents the maximum acceptable gas concentration level. If it exceeds alerts will be shown.



### 6. Project Description-

The "Gas Explosion Detecting and Alerting System using IoT" is an innovative safety solution designed for the oil and gas industry to detect hazardous gas leaks and promptly alert both on-site workers and remote management. Utilising the MQ135 gas sensor, the system can identify various harmful gases such as ammonia, sulphur, benzene, CO<sub>2</sub>, and smoke. The sensor is connected to an Arduino NANO, which triggers an alarm buzzer and LED light to immediately warn nearby workers of any detected leaks. Additionally, the Arduino NANO is integrated with a GSM module to send SMS alerts to designated personnel, ensuring swift action even if they are off-site. This IoT-enabled system not only enhances real-time monitoring and comprehensive detection capabilities but also significantly improves safety, operational efficiency, and environmental protection by providing quick and reliable alerts, thus preventing potential accidents and ensuring regulatory compliance.

### 7. Experimental Result-

The primary results of this project encompass the development and testing of a functional IoT-

based gas explosion detection and alerting system. The system successfully utilises the MQ-135 gas sensor module to detect the presence of combustible gases like methane. The Arduino code effectively interprets sensor readings and compares them to a predefined threshold. Upon exceeding the threshold, the system triggers an appropriate alerting sequence. The system generates a loud and noticeable audible alert through the buzzer or alarm, prompting immediate action from occupants in the vicinity. The LED provides a clear visual confirmation of a potential gas leak, even in dimly lit environments. The GSM shield and SIM card combination facilitates the transmission of SMS alerts to designated phone numbers, ensuring notification of relevant authorities or individuals. The project serves as a valuable educational tool, highlighting the importance of gas leak detection and safety protocols. It encourages users to Install the system in a well-ventilated location to prevent sensor saturation, regularly inspect and maintain gas lines and appliances, have a clear evacuation plan in place for the event of a gas leak, contact a qualified gas service provider to address any detected leaks safely and effectively.

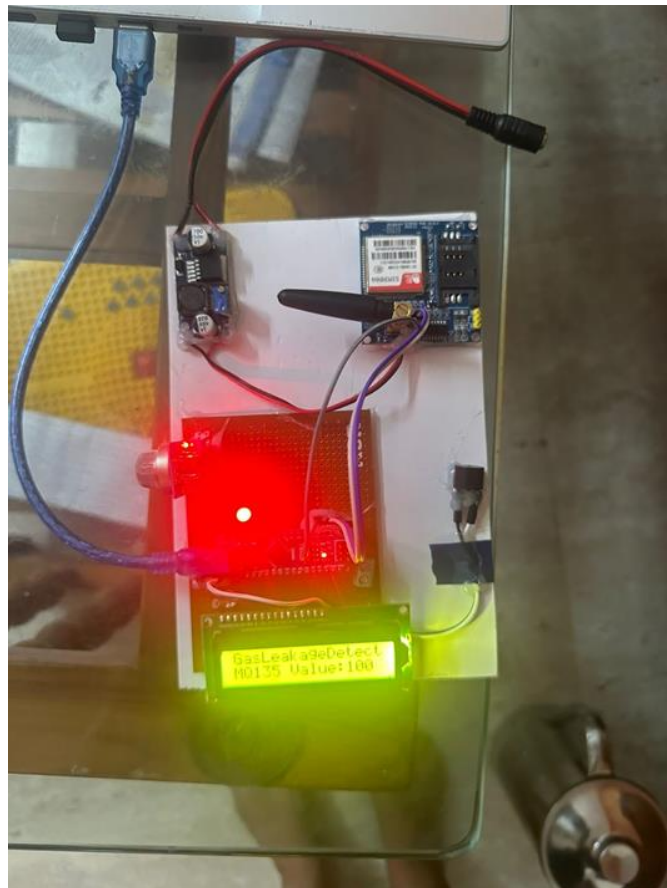


Figure 7.1 : Connections in the board



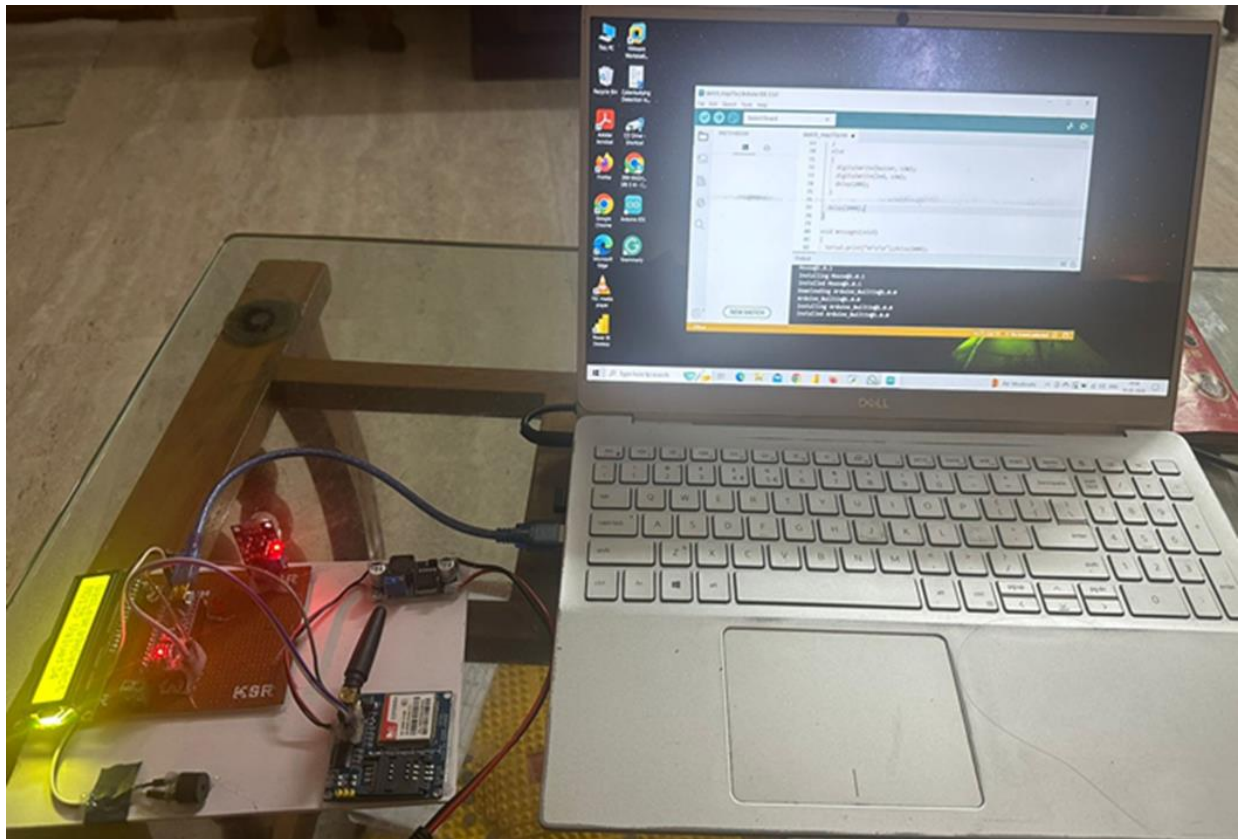


Figure 7.2 :Working Model connected with Arduino IDE

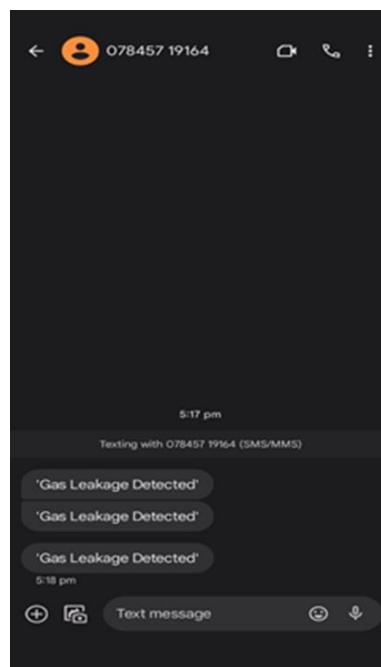


Figure 7.3: Alert Message

## **8. Conclusion and Future Enhancement-**

### **8.1 Conclusion-**

This project has presented a cost-effective gas explosion detection and alerting system leveraging the power of the Internet of Things (IoT). By utilising readily available components and a multi-layered approach, the system offers a proactive solution for safeguarding homes, businesses, and industrial facilities from the dangers of gas leaks. The system effectively addresses the limitations of traditional gas leak detection methods, which often rely on human senses and infrequent inspections. The continuous monitoring capabilities of the MQ-135 sensor, coupled with the Arduino's processing power and the GSM shield's communication features, create a robust system for early detection and timely notification. The multi-faceted alerting system, encompassing a loud buzzer or alarm, a bright LED, and SMS notifications, ensures that occupants and authorities are alerted promptly, allowing for swift evacuation and corrective action.

### **8.2 Future Enhancements-**

- **Cloud Connectivity:** Consider incorporating cloud connectivity. This would enable remote monitoring of gas concentration levels, allowing for real-time data analysis and potentially triggering automated responses, such as shutting off gas valves remotely.
- **Machine Learning and AI:** Implement machine learning algorithms to analyse sensor data over time and learn patterns. This could help the system distinguish between normal gas fluctuations and actual leaks, further reducing false alarms.
- **Mobile App Integration:** Develop a mobile application that allows users to monitor gas concentration levels remotely, receive alerts, and potentially control the system settings.
- **Sensor Integration:** Explore the integration of additional sensors for a more comprehensive approach. Sensors for detecting smoke, carbon monoxide (CO), or temperature fluctuations could provide a more holistic picture of potential hazards.

## **9. References-**

[1] “Energy-Efficient routing protocol for reliable low-latency internet of Things in oil and gas pipeline monitoring” proposed by karam S N, Bila K, Year:2024

[2] “Evaluating a novel gas sensor for ambient monitoring in automated life science laboratories” by MFR, Roddelkopf T, Year:2022.

[3] “Modelling and implementation of a low-cost IoT-smart weather monitoring station and air quality assessment based on fuzzy inference model and MQTT protocol” by Fahim M, El Mhouthi, Year:2023

[4] “Enhancing data transmission in duct air quality monitoring using mesh network strategy for LoRa” by Mulick A, Abd Rahman AH, Year:2023

**[5] “Quantifying non-steady state natural gas leakage from the pipelines using an innovative sensor network and model for subsurface emissions – InSENSE” by Lo JH, Smits KM, Year: 2024**

**[6] “High-resolution geoelectrical characterization and monitoring of natural fluids emission systems to understand possible gas leakages from geological carbon storage reservoirs” by Salone R, De Paola, Year:2023**

**[7] “A novel benzo hemi cyanine-based fluorescent probe for susceptible visualising detection of phosgene” by Shao S, Bao C, Year: 2023**

**[8] “Characterization of H<sub>2</sub>S QEPAS detection in methane-based gas leaks dispersed into environment” by Olivieri M,Menduni G, Year: 2023**

**[9] “Evaluating of IAQ-Index and TVOC Parameter-Based Sensors for Hazardous Gases Detection and Alarming Systems” by Al-okby , Neubert S, Year:2021**

**[10] “Mobile Detection and Alarming Systems for Hazardous Gases and Volatile Chemicals in Laboratories and Industrial Locations” by Al-okby, Neubert S, Year:2021.**