

Original Article

# Sensor-Based Gas Leakage Detector System

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**Abstract:** Especially in cities, liquefied petroleum gas, or LPG, is a primary fuel source since it is more environmentally friendly than charcoal and firewood. One of the biggest issues in the industrial, residential, and other sectors is gas leaks. Due to an increase in gas leaks, home security is becoming a serious concern. Gas leaks are a major concern for ateliers, residential areas, and gas-powered vehicles such as buses, autos, and compressed natural gas (CNG). Installing a gas leak detection kit in susceptible locations is one way to prevent mishaps caused by gas leaks. This paper's goal is to suggest and examine a system design for automatically detecting, alerting, and controlling gas leaks. An alerting mechanism for users is also included in this suggested system. The sensor that powers the device is capable of quickly identifying gas leaks.

**Keywords:** Sensor, Gas Leakage, Petroleum Gas, LPG.

## INTRODUCTION

Gas leaks are a major issue that are seen in many homes, businesses, and automobiles these days, including buses, autos, and compressed natural gas (CNG) vehicles. It has been observed that hazardous mishaps are caused by gas leaks. The flammable mixture of hydrocarbon gases known as liquefied petroleum gas (LPG), or propane, is used as fuel in a variety of settings, including homes, hostels, businesses, cars, and vehicles. Its advantageous qualities include a high calorific value, minimal environmental damage, and less smoke and soot. Because of its extreme inflammability, liquid petroleum gas (LPG) can catch fire even when it is some distance away from the leak. The main chemical components of this energy source are propane and butane, both of which are extremely combustible. These gases are easily combusted. LPG is primarily used for cooking in homes. An explosion could result from gases that have spilled during a leak. Gas leaks cause a variety of mishaps that cause property damage as well as injury to people.

Home fires have been happening more often, and in recent years, there has been an increased risk to both human life and property. The physical characteristics of an object, such as its flammability and toxicity, determine its hazards of explosion, fire, and asphyxia. In recent years, there has been an increase in the number of fatalities brought on by gas cylinder explosions. One incident when a gas leak caused an accident is the Bhopal gas catastrophe. Such explosions are caused by worn-out regulators, outdated valves, inadequate inspection of gas cylinders, inadequate cylinder quality, and insufficient knowledge in handling gas cylinders. Thus, in order to keep people safe, gas leaks need to be found and fixed.

To make it easier for most people to identify leakage, odorants like ethane thiol are added to LPG. That being said, certain individuals with diminished senses of smell might not be able to depend on this built-in safety precaution. A gas leak detector becomes essential and aids in shielding individuals from the risks associated with gas leaks. Several methods of gas detection are employed. This work proposes and discusses a low-cost sophisticated sensor-based gas leakage detector, alarm, and control system. The system is incredibly effective, portable, easy to use, affordable, and tiny in size.

The gas detection device is already on the market and is widely used in a variety of settings, including industries with high explosion risks that could result in extensive damage and human casualties; homes with LPG gas used almost exclusively for daily needs, where it can detect LPG gas leaks; cars, where the majority of vehicles have cylinders, and many more locations. It is a mixture of commercial propane and butane. Because of its high flammability, LPG leaks frequently result in accidents. Therefore, it's essential to detect and stop gas leaks. There are numerous ways to classify gas detectors. Based on the kind of gas they identify, the technologies driving the



sensor's output, and the parts influencing the sensor's functionality (semiconductors, oxidation, catalytic, photoionization, infrared, etc.), they are categorized. We use a wide range of devices in our everyday lives for different purposes, and most of them have the capacity to release any kind of gas or chemical into the air when they are operating. It is frequently impossible for humans to monitor the concentration levels of gas leaks or to determine whether or not there is a leak. If there is a gas leak while no one is nearby, it could explode at the slightest spark or the surrounding area could be filled with toxic gas, which could cause asphyxia and respiratory problems.

Although there are numerous applications for detecting and tracking gas leaks, researchers will continue to work to create more sophisticated applications that will be less expensive. According to the authors' proposed system, MQ-5 sensors are used for LPG gas detection and monitoring. The alarm message will appear on the LCD along with the buzzer in the system when gas leaking is detected. Additionally, the notification will be sent to the application or system owner while the gas is being monitored depending on the cylinder weight, which is determined by the load sensor. The proposed system's creators employed a push button to quickly transmit message data via a Wi-Fi module that activates when there is a gas leak and is coupled to an Arduino UNO.

According to the authors' suggested system, the sensor used to detect LPG gas is MQ-6; the sensor used to detect methane gas is MQ-4; and the sensor used to detect benzene is MQ-135. PPM will be the format in which the sensor output is provided. Moreover, ESP32 is utilized for message sending and receiving. The system that the authors have proposed is intended for use in monitoring gas where a message is sent. Node MCUs are used as sensors in places where load sensors are constantly keeping an eye on the cylinder. Ubidots will be used to display the weight if it is less. The authors of [5] suggested a system in which low-cost LPG gas management is suggested. In addition to detection and monitoring, the system computes the humidity content and temperature.

A gas detector, which is frequently a component of a safety system, is a device that detects the presence of gases in an area. Homeappliances and other physical components. A gas detector can sound an alert to operators in the area where the leak is occurring, giving them the chance to evacuate. The hardware layer conceals abstraction in order to utilize data. There are numerous gases that can be hazardous to organic life, including humans and animals, which make this kind of equipment crucial.

- 1) Oxygen depletion, poisonous, flammable, and combustible gases can all be found with gas detectors. This kind of equipment is frequently used in industry to monitor production processes and cutting-edge technology like photovoltaics. It can be found in places like oil rigs. They could be applied to fighting fires.
- 2) In this work whenever the gas is leaked it is sensed by the sensor and it sends signal through the processor to buzzer .The ppm can be seen in the LCD display. Whenever the gas leakage reaches the ppm of 100 it will send signal to the buzzer and the buzzer will ring and it will alert the people around that the gas is leaking .

#### **Harmful gas detection:**

In any company, the ability to detect harmful gases like CO, H<sub>2</sub>S, and methane is crucial for preventing unintentional leaks and their associated hazards like explosions or poisoning. With the use of an IoT-powered gas monitoring system, the presence of these gases in commercial and industrial buildings may be easily recognized. Additionally, a gas detector or other sensor device is an essential component of safe industrial operations. The sensor-enabled technology lessens the likelihood of a high gas leak.

#### **Fire hazard prevention:**

In order to prevent dangerous outcomes like fire breakouts, the gas sensors assist in detecting the concentration of the gases present in the atmosphere. It is also a necessary solution to protect the plant's machinery and personnel from fire dangers. It successfully identifies dangerous gases such as methane and propane and notifies the plant authorities, averting an unplanned fire on the property. Additionally, a gas monitoring system creates notifications about the temperature rise using gas analyzers. This enables the administration to stop dangerous fire explosions right away.

### Oxygen Level Measurement:

Since many pitmen have perished during mining expeditions owing to a shortage of oxygen, sensing the presence of gases is essential to conducting industrial activities. For workers in mines or densely populated industrial facilities, a sudden drop in oxygen levels can cause vertigo, brain damage, or even death. Because a gas monitoring system keeps the oxygen levels in check and reflects your personnel' best efforts, it greatly benefits the industries. Additionally, this technology generates real-time notifications about falling oxygen levels, providing ample time to take the appropriate action and evacuate the premises well before health problems arise

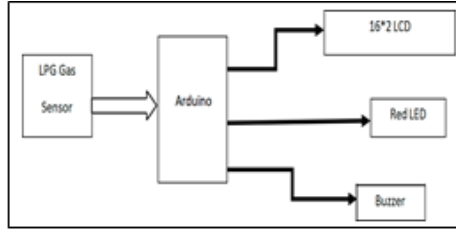


Figure 1: Block Diagram

In this case, LPG gas is detected using semiconductor sensors. It makes use of a semiconductor MQ6 sensor. SnO<sub>2</sub>, the sensitive material used in the MQ-6 gas sensor, has a reduced conductivity in pure air. The sensor conductivity rises in proportion to the increasing gas concentration when the target flammable gas is present. The MQ6 gas sensor responds well to natural gas and is very sensitive to propane, butane, and LPG. The sensor is affordable and useful in a variety of settings. It can identify several flammable gases, including methane. The range of gas concentrations that the MQ-6 can identify is 200–10,000 ppm. The output of the sensor is an analogue resistance. The block diagram for the gas leak detection and alert system is displayed in the above figure.

The MQ-6 gas sensor and Arduino UNO R3 are the foundation of this system. The sensor will provide a digital output of 1 if gas is detected in the atmosphere, and a digital output of 0 otherwise. The sensor output will be received by Arduino as a digital input. The buzzer and LCD will both begin to tune in if the sensor output is high, indicating that "Gas detected :Yes." The buzzer won't tune in and the LCD will display "Gas detected: No" if the sensor output is low. The buzzer typically consists of several switches or sensors that are connected to a control unit to detect which button was pressed or whether a predetermined amount of time has passed. It also typically illuminates a light on the appreciate button or control panel and emits a continuous or sporadic buzzing or beeping sound as a warning.

### GAS SENSORS

A device that measures the amount or presence of gas in the atmosphere is called a gas sensor. By altering the material's resistance inside the sensor, the sensor generates a corresponding potential difference based on the gas concentration. This potential difference can be detected as output voltage. It is possible to estimate the kind and concentration of the gas using this voltage value. The sensing material that is inside the sensor determines what kind of gas it can detect. These sensors are typically offered as modules that include comparators. These comparators can be adjusted to a certain gas concentration threshold value. The digital pins go high when the gas concentration surpasses this threshold value. The concentration of gas can be measured using the analogue pin.

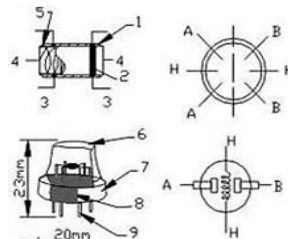


Figure 2: GAS SENSOR PINS

### Mq6 Gas Sensor:

The pin diagram for the MQ6 sensor is shown in fig. 2.1. On the other hand, the left image shows a MQ6 sensor that is module-based and interfaces with the microcontroller unit; the image also displays the module's pin diagram. Pin 1 is VCC, Pin 2 is the GND, Pin 3 is the Digital out (Logic low when gas is detected.) and Pin 4 is the Analog output. The pot is used to adjust the sensitivity. It is not RL. The RL resistor is the right resistor of the DOUT LED.

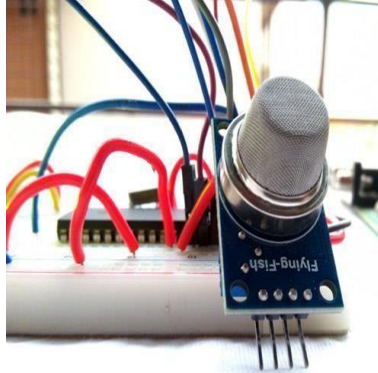


Figure 3: GASSENSOR

A detecting resistance and a heating element are features of every MQ series sensor. The sensing resistance changes in response to the gas concentration, and the concentration of the gas can be determined by detecting this change in resistance. A logarithmic graph is provided by all MQ sensors, and it is crucial for measuring the gas concentration in parts per million. An overview of the gas concentration is shown on the graph along with the RS/RO ratio.

### Arduino-Uno:

The Arduino-uno is an open-source, programmable microcontroller board that is inexpensive, versatile, and simple to use. It may be used in many different types of electronic projects. This board can control relays, LEDs, servos, and motors as an output and can interact with other Arduino boards, Arduino shields, and Raspberry Pi boards.

### LCD Display:



Figure 4: Line Hitachi HD44780 Display

'Smart LCD' displays, like the one in fig. 2.12, are increasingly being used by microcontroller devices to output visual data. The connection between a PIC microcontroller and a Hitachi LCD display is covered in the discussion that follows. In addition to the usual ASCII character set, Hitachi LCD panels also feature mathematics, Greek, and Japanese symbols..

### LCD Pins:

The display needs 11 I/O lines and a +5V supply for an 8-bit data bus. It just takes the supply lines plus seven more lines for a 4-bit data bus. Data lines are tri-state, or in a state of high impedance (as though they are disconnected) while the LCD display is not enabled. This implies that they do not obstruct the microcontroller's ability to function when the display is not being addressed. Three "control" lines from the microcontroller are also

needed by the LCD.

The procedure for reading data from the LCD is the same, except a high control line R/W is required. The LCD will reset and wait for instructions when we send it a high. Following a reset, the LCD display typically receives the following commands: turning on the display, activating the cursor, and writing characters from left to right. The LCD is prepared to accept more data or commands when it has been initialised. When it detects a character, it moves the cursor one place to the right and writes the character on the screen. The Cursor indicates where a character will be written after that. Setting up the beginning address is the initial step in writing a string of characters; subsequent characters are sent one at a time. Data display (DD) RAM holds the characters that can be displayed on the screen. DDRAM has a size of 80 bytes..

## SIMULATION

### ATmega328:

Within the megaAVR family of microcontrollers, Atmel developed the ATmega328, a single-chip microcontroller that was ultimately bought by Microchip Technologies in 2016. The 8-bit RISC CPU core of Harvard Architecture has been updated.

### Simulation Using Tinker cad:

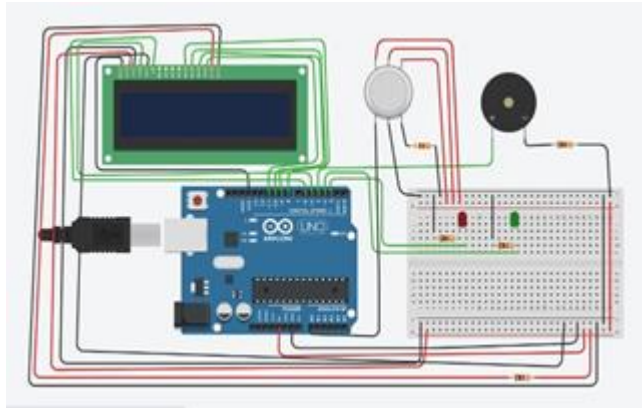


Figure 5: SIMULATION DIAGRAM

## CONCLUSION

This work proposes and discusses the design of a sensor-based automatic gas leakage detector with an alert and control system. This gas detector is an inexpensive, low-power, lightweight, portable, safe, user-friendly, effective, multi-featured, and straightforward system device. Not only will gas leak detection be important for the health sector, but it will also boost the economy since wasted gas not only ruins the environment but also negatively impacts our economy. The suggested system will just set you back USD 10, which even the poorest individuals may certainly afford. It is evident from the accessible literature that not much work has been done on developing a smart gas detection system. This system will eventually incorporate more sophisticated functions that will increase user safety and comfort. The development of smart gas sensors as a result of the widespread use of mobile devices has greatly expanded the range of applications for these sensors. Over the upcoming years, the necessity to ensure worker safety is anticipated to be the primary driving force for the market.

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