MQ-2 Gas Sensor using Micro Controller Arduino Uno for LPG Leakage with Short Message Service as a Media Information

Sohibun*, I Daruwati, R G Hatika and D Mardiansyah
University of Pasir Pangaraian, 28457 Kumu Desa Rambah, Riau, Indonesia
bie.idsohib@gmail.com

Abstract. This research was to detect leakage of liquified petroleum gas (LPG) gas automatically. Design of this device consists of a gas detection sensors LPG MQ-2, which serves to detect the levels of LPG in the air, the sensor signal analog is converted to digital by the ADC and processed by a microcontroller Arduino Uno to command activation of the buzzer and SMS (short message service), sensor system is also capable of displaying a LPG gas concentration detected by the LCD in ppm. The study was conducted at three different space conditions of the open, semi-open and closed, based on the distance detection and characterization. The analysis of the data obtained, that the tool to work optimally at a distance of 3 cm closer to the source of the leak tool then the maximum LPG gas leak detection tools. Based on the characterization of the sensor that is an accuracy of 1 V to 2.6 V and repeatability error of the three conditions of the room is < 10%, so that the tool is expected to cope with and anticipate the risk of accidents due to leakage of LPG gas early and real time.

1. Introduction
According of Indonesia regulation number 104 in 2017 about the supplying and using liquified petroleum gas (LPG) for cooking at home. Since that regulation applied, so that all of community must use LPG for cooking and using kerosene is forbidden. LPG was become once a standard cooking fuel in Indonesia. LPG is used for cooking in many countries for economic reasons, for convenience or because it is the preferred fuel source. LPG also referred to as simply propane or butane, are flammable mixtures of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles. LPG can be converted into alkylate which is a premium gasoline blending stock because it has exceptional antiknock properties and gives clean burning [1].

LPG is prepared by refining petroleum or “wet” natural gas, and is almost entirely derived from fossil fuel sources, being manufactured during the refining of petroleum (crude oil), or extracted from petroleum or natural gas streams as they emerge from the ground. It was first produced in 1910 by Dr. Walter Snelling, and the first commercial products appeared in 1912 [2]. It currently provides about 3% of all energy consumed, and burns relatively cleanly with no soot and very few sulfur emissions. As it is a gas, it does not pose ground or water pollution hazards, but it can cause air pollution. LPG has a typical specific calorific value of 46.1 MJ/kg compared with 42.5 MJ/kg for fuel oil and 43.5 MJ/kg for premium grade petrol (gasoline). However, its energy density per volume unit of 26 MJ/L is
lower than either that of petrol or fuel oil, as its relative density is lower (about 0.5–0.58 kg/L, compared to 0.71–0.77 kg/L for gasoline) [3].

However, using LPG made some problems like a burning and accident caused by LPG leak and explodes. The risk of using LPG commonly because some mistakes when used LPG cylinder (gas tank) like mistake when put in regulator, bad seal, regulator was not standard, and human error.

Technological advances, especially in the field of electronic technology, so many people needs of electronic applications to help facilitate human to know work on gas leakage LPG, then the necessary tools to detect and marker of danger automatically if the gas leak one of that using Arduino Uno Microcontroller.

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU lesser general public license (LGPL) or the GNU general public license (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including universal serial bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project [4].

MQ-2 sensor is used as a LPG leak sensor, the function of this sensor is easy, low-cost, and highly sensitive and has a fast response time to identified LPG leak. A sensor is an apparatus that serves as a detection of symptoms, a signal that comes from a change of energy [5]. Furthermore, coupled with the use of a buzzer that can issue a loud sound when there is a leakage of LPG gas.

Short message service (SMS) with GSM card sim 800L is used by user who use LPG for information. User will get some message from the MQ sensor Arduino Uno when leaks happened and make some fast response. So user can controlling LPG when user leave kitchen real time [6].
2. Methodology

In this research first step is make prototype of LPG Leaks, with use hardware and software.

![Prototype design](image1)

Figure 2. System of LPG leaks (hardware).

Than listing program that save in Arduino Uno software make some instructions and hardware as a microcontroller loading. Design of the prototype LPG leaks detection shows in Figure 3.

![Prototype design](image2)

Figure 3. Prototype design.
For to know how the prototype works with the true instructions, so the researcher testing the sensor characteristic, first how the prototype work according the distance between prototype and LPG leaks than microcontroller will read and write the gas concentrate. Second how the prototype work according sensor system in accuracy and repeatability [7].

2.1. Accuracy

| Measuring spot | Process | Rating Datasheet (V) |
|----------------|---------|----------------------|
| TP 1           | Input   | 5–5.2                |
| TP 2           | Output  | 0–5                  |

2.2. Repeatability

Error repeatability will be knew with this function:

\[ \delta = \frac{\Delta V}{FS} \times 100\% \]  

where, \( \delta \) is error repeatability, \( \Delta V = \text{max} - \text{min} \) (V), and FS (full scale).

Error repeatability is caused by sensor disability to make the same value with same process or condition, it because material characteristic, temperature’s annoying, and area conditions.

This condition means as a maximum different between output views define with two calibration process showed by percentage of FS [8].

![Figure 4. How to determine error repeatability sensor.](image)

3. Result and discussion

3.1. The result of LPG leak prototype design

The design of LPG leak detection prototype is a hardware and software models. A hardware device is microcontroller Arduino Uno, MQ-2 gas sensor, SIM Card 800L, Buzzer, jumper wire, and LCD 16 \( \times \) 2. The software devices is Arduino software system (Arduino IDE) with program matrix and the result of this design shows in Figure 5.
3.2. Feasibility test based on detection distance

Feasibility test did it with experiment that aims to know the performance and sensitivity of the sensor in detecting leakage of LPG gas conducted in 3 different room conditions that is closed room, semi open and open with 10 point distance (cm), it made 5 times.

![Figure 6. Prototype testing in 3 conditions.](image)

From the graph shows that there is a decrease in the chart in three conditions, open space, semi open, and closed. This is because the further distance between the gas and the sensor gas concentration
(ppm) will detect the leakage of LPG gas, this shows that the sensor system is more sensitive when closer to the source of stimulation.

3.3. Testing prototype while stove on
This test serves to detect the possibility of error reading LPG gas leakage when the cooking process takes place so it is not dangerous.

![Testing prototype while stove on.](image)

The result was that the detector did not detected any gas leakage. It caused propane and butane levels contained in the LPG gas has changed the element and mixed with oxygen (to fire) so that the detector no longer detects any leakage.

3.4. Result of sensor perform test based on sensor system characteristic
The test is performed to express the accuracy of the proximity of input and output measurement with true value according to Table 1, and also to find out the repeatability value of the sensor response to the existence of a gas odor source and can return to its original position when no gas odor source is done on 3 condition of the room.

3.4.1. Open. From the results of the graph obtained is the accuracy of measuring the output of 1–2 V and the repeatability of 4.13%.
3.4.2. Semi open. From the output measurement accuracy was 1–2.4 V and the repeatability was 1.05%.

3.4.3. Closed room. From the result of output measurement accuracy equal to 1.1–2.6 V and result of repeatability equal to 0.724%. So that the percentage in these three conditions of space is quite small (< 10%), so that this system can be used repeatability under any condition, with this property the system will automatically return to normal when no more gas is detected.
4. Conclusion

After going through the design phase, designing, and experimenting and data processing, it can be concluded that the designed prototype is capable of detecting and displaying LPG gas detected concentration value in buffer-assisted ppm units and SMS as an information medium that is monitored in real time and at the time of stove condition light up does not pose a danger. The MQ-2 Sensor characteristics has good sensitivity to respond quickly if there is LPG gas in the air and can be used repeatedly (repeatability). Differences in space conditions could affect the sensitivity of the sensor MQ-2, need to consider the distance laying the sensor with the gas source because the closer the distance the more concentrated gas will be detected. In order to perform more efficient checks need to design a better prototype with microcontroller system that can be developed more widely and varied as needed.

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