Early Detection of Leaks on Gas Cylinders Using Arduino Based MQ-6 Sensors

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ABSTRACT: Liquid Petroleum Gas (LPG) which has components in the form of propane and butane currently has an important role for people in the household and industry. However, there are things that must be considered when using LPG in terms of safety. This is because the gas is volatile and there is a possibility of leaking which will be very prone to cause explosion or fire hazard. The gas leak early detection device is a very appropriate effort in dealing with early detection of LPG leak in order to minimize the occurrence. This study was designed using a prototype system that functions as a simulation if there is a gas leak in a room by using the MQ-6 sensor which detects LPG content in the room. The way this tool works is that, if there is a gas leak, the MQ-6 sensor will detect it and then send the data to the microcontroller on Arduino in the form of analog data. In the MQ-6 sensor-based LPG leak early detection system using Arduino it has been successfully running according to an algorithm that has been designed and installed before in the test results, and send a warning message to the specified number. This system can detect gas faster in a closed room, on the contrary if in an open room the sensor can detect longer because the level of contaminated gas will be immediately wasted into the air.

Keywords: Arduino, LPG gas, MQ-6 sensor, and microcontroller.

1. Introduction

LPG (liquidified petroleum gas) is a liquefied petroleum gas by adding pressure and lowering the temperature of the gas so that the gas becomes liquid, LPG plays an important role for the needs of society now with the use of LPG kerosene which was very high and even in 2017 land is very rarely used. Quoted from Republika.co.id "Consumption of LPG in Indonesia has increased in 2007 only around one million metric tons per year almost reached 7 million metric tons in 2016. The figure grew by 700 percent for nine years. Pertamina's Deputy President Director Ahmad Bambang said, the increase in LPG consumption was due to the program to convert BBM to LPG conducted the government for household needs since 2007 and for fishing boat engines which are carried out starting in 2016, the plan will be continued in 2017 " [1].
From the above data, the increase in LPG use is very significant, but in terms of the conversion of BBM to LPG there are problems that have arisen, such as image 1 data obtained from the BKPN (Investment Coordinating Board) institution about LPG gas explosions from 2007 to 2010[2]. Based on the above problems, the idea arises to make "LPG GAS Cylinders Leak Detectors Using Arduino Based MQ-6 Sensors" expected by making this system can reduce the number of cases of LPG GAS explosions.

The first research design a telemetry system from the ammonia gas concentration measurement unit to the data collector to monitor of ammonia gas in realtime and continuously. The data collected is integrated with software, so it can serve as an early warning of changes in the level of concentration of ammonia gas through the deployment of short message system (SMS Gateway) to the public or the industry responsible[3].

The second research produced an LPG gas cylinder leak detector design using the MQ-6 sensor as gas sensor, and an ethernet shield as a module on the arduino uno microcontroller to connect arduino to the internet network[4]. The other research produced a design og LPG leak detection equipment using MQ-6 sensor as gas sensor, and GSM module as sender of SMS notification to user’s mobile phone [5].

The research discussed the prototype of room refresher system from cigarette smoke and LPG gas based on ATMega 8535. The design of air refresher devices from cigarette smoke and LPG based microcontroller ATMega 8535 with MQ-9 sensors through the stage of making hard traps (hardware) and software (software). Hardware consists of a box that is a room prototype and there is a MQ-9 sensor to detect cigarette smoke and LPG gas. ATMega 8535 controller as a controller, buzzer as an early warning that there is detected cigarette smoke and LPG gas and fans that will be active to remove cigarette smoke and LPG gas from the room to the outside[6].

The research design of methane gas detection devices in Arduino Uno-based coal mines. This final project is capable of detecting methane gas using the MQ-4 gas sensor. So when the sensor detects methane gas, the system activates the buzzer and indicator lights (LED). In addition, this tool is also equipped with an LCD to provide information on methane gas leakage or as a monitoring so that users can always observe it [7]. From a number of references above, it can be concluded that technology is now increasingly advanced with the existence of intelligent systems so that all the hazards that exist in the surrounding environment can be minimized by making detection devices such as those made above.

The research produced LPG detection system because most of LPG explosions are caused by undetected gas leakage in the pre-detection condition. The purpose of this system is to detect gas leakage, neutralize it, and prevent the explosion. Gas leakage could happen due to improper regulator installation or the hose is broken. This detection should not work in just one location because gas can leak at the gas regulator and its hose. Therefore, Wireless Sensor Network (WSN) is one of the
methods that suitable for detecting gas leakage in the wider area. This method uses two or more gas sensors to detect leakage in two or more locations around the gas tube and its distribution line. WSN system works based on gas sensor MQ-6 and wireless module Bluetooth HC-05. Explosion prevention system works based on alarm/buzzer, exhaust fan, and automatic gas regulator. If the gas leaks, the sensor will send its data wirelessly to Arduino. Then, explosion prevention system will be activated. The system will turn the alarm/buzzer on, automatically releases gas regulator, and neutralizes the air with the exhaust fan. Both systems will be fully controlled by Arduino platform[8].

This research developed system device monitoring and early detection of gas leaks by utilizing gas sensors MQ-4 and AVR microcontroller family as control devices. The system is also equipped with XBee PRO S2B nirkable devices as the interface to the wireless networking system that is used to transmit sensor data from the detection point to the monitoring center equipped with a PC and software integrated Visual Basic. Gas leak alert is sent with the message formats through social networking Gtalk[9].

This research deals with the development of an advance technology gas sensor for detection, monitoring and control system of LPG leakage. Using DC motor the stove knob is automatically controlled[10]. The research procused gas leak sensor is such a device which detects the gas leaks at initial levels and warns the people of the same. This paper basically deals with the development of a simple gas leak detector at the initial stage and then transforming this simple device into a most advanced gas detector system in the future[11].

This research deals with the detection, monitoring and control system of LPG leakage. Using relay DC motor the stove knob is automatically controlled. Along with safety measures the system has additional advantage of automatic rebooking of cylinder when the level of gas goes below the normal weight of cylinder[12].

2. Research Method
2.1. Program in Arduino IDE
In this study, Arduino IDE software for Windows is used, with serials, namely series 1.8.5.0. This software is built-in Arduino which is useful in compiling the source code for programming the Arduino board. This study uses the GSM SIM800l Module which functions to send messages, SIM800L GSM Module can be accessed by adding a library to the program source code that will be created, as shown in Figure 3 which displays the addition of the GPRS SHIELD library. sim card on the SIM800L GSM Module, how to add a library in Arduino that is by using hastag included with the name of the library that will be used.

2.2. Display Prototype
In the prototype section the gas leak detection system consists of several components connected including:
2.2.1 Arduino Uno board that functions as a controller of all existing components.
2.2.2 Project board is a place to connect between components one to another component.
2.2.3 Sensor MQ-6 is a sensor that detects the intensity of gas in the room.
2.2.4 SIM800L GSM module is a hardware that functions as a medium for sending SMS gateways to gas leak warnings.
2.2.5 The fan functions as a gas suction device in the room.
2.2.6 channel relay functions as a regulator of electric current from outside.
2.2.7 Led lights as a warning for a gas leak.
2.2.8 Jumper cable serves as a liaison between components

2.3. SMS Delivery Scheme
From the schema in Figure 4, it can be seen that the pranti in the system is 3, namely there are inputs, processes and outputs. In the hardware input process that is used is the MQ-6 sensor which functions as a gas detector sent with data in the form of analog data to the Arduino microcontroller,
after input is available, then enter the data processing to be entered into conditioning in the microcontroller that has been programmed, in this process the Arduino microcontroller acts as a process device and that will control all output devices. On the hardware output device that is used is an LED light that serves to indicate a leak in the gas cylinder, a fan that functions as a device that sucks gas in the room and the last is a SIM800L module that functions as a message sending media if a gas leak is detected in the room this condition SIM800L module has a weakness, namely in the network search section which is often unreadable in the network process, it is not readable, the sms gateway that has been conditioned is not delivered, for the scheme flow can be seen in the picture 2.

3. Result and Analysis

3.1. Block Program
In the block diagram there are 3 blocks consisting of input, process and output. The input block contains the detection of the gas sensor MQ-6, then there is a block process in which there is an Arduino microcontroller component which acts to receive the value sent by the gas sensor MQ-6 and finally the output block displays the output in the form of LED lights SMS gateway.

The input block here is the MQ-6 gas sensor that reads the analog data input value, in this condition the sensor will turn on if the Arduino microcontroller has power, the sensor will then start reading and sending analog data to the microcontroller and then enter the block process.

The block process acts as the recipient of data that is sent from the input block and then processed to do the conditioning that was previously programmed using the Arduino IDE software. After conditioning, the output will be continued to the output block.

The output block consists of a led light as a warning of a gas leak in the room then the fan functions as a gas suction in the fan room will automatically turn on if the block process sends a command that is when there is a gas leak in the room, the fan will automatically turn off if the analog value is the input block has returned to normal and the last one is the GSM SIM800L module which functions as a message sending media in the event of a gas leak in the room, sending messages will occur repeatedly with a delay of 5 seconds if the gas conditions in the room are still high intensity. Block diagram can be seen in the figure 3.
3.2. Black Box Testing

Black box testing based on prototype systems for early detection of gas leaks using Arduino Microcontrollers can be seen in Table 1. Based on black box testing in Table 1 it appears that all the processes that have been tested can run well. The first scenario of testing is by flowing electric current on the Arduino microcontroller board with the results of all components running well including the SIM800l module which automatically installs and automatically searches for the GSM network then there is the MQ-6 sensor that reads the gas intensity in the room. The second test is to bring the gas closer to the MQ-6 sensor with the result that it can detect a gas leak then turn on the led as a sign of danger and turn on the fan in the room, and give a warning by sending an sms gateway.

Table 1. Testing Black Boxes

| No | Scenario                        | Test Result                                      | Security                           | Conclusion |
|----|---------------------------------|-------------------------------------------------|------------------------------------|------------|
| 1  | Provides a power source         | Able to install all components and turn on LEDs and fans and give SMS alerts | Read automatically the value of gas content in the room | Valid      |
| 2  | Bring the gas source closer to the MQ-6 sensor | Able to turn on LEDs and fans and give SMS alerts | The LED and Fan Lights up as a warning and sends a message that there is a gas leak | Valid      |

3.3. Testing the GAS Leak Detection System Algorithm

Algorithms in designing tools are very important in order to obtain accuracy in terms of control. The algorithm functions as a reference for making programs where the algorithm contains important points contained in the programming logic that will be made. As in Table 2 below, how the detector system works. Range ADC is the value of a small amount of gas in the air that is read by the sensor. The condition is an order from the microcontroller to the output, based on the program logic given in this test it can be concluded that the algorithm implanted in the microcontroller tool is appropriate.

Table 2. Testing of the gas leak detection system algorithm

| Analog data | Condition (Output) | explanation         |
|-------------|--------------------|---------------------|
| <=199       | Off                | There is no message sended Secure |
| >=200 & <=400 | On                | "Gas content increases, Warning !!!" Standby |
| >=400       | On                | "Indicated Gas Leaks !! Danger !!" Danger |

3.4. GAS Sensor Testing in MQ-6

The gas sensor testing in MQ-6 is done by using a small size gas cylinder (the size of a perfume can) by spraying the gas at a predetermined distance carried out in the room. It can be concluded in the results of table 3 this test is an analog value read by the MQ-6 sensor depending on distance and wind conditions in the room. The distance gas source in the range of 15 cm down the readable value is high, namely 300 to 400 and at a distance of 15 to above the analog value that is read is getting smaller because the gas source does not go directly to the MQ-6 sensor / gas source exposed to wind. Table testing of Gas Sensor MQ-6 can be seen in the Table 3.
| Testing to- | Distance (cm) | Value of Analog Sensor MQ-6 Data at Seconds To-15(s) | Testing Scenario | Test Result |
|---|---|---|---|---|
| 1 | - | 50 ppm 54 ppm 54 ppm | There is no gas source | The led and fan do not turn on, do not send SMS alerts |
| 2 | 2 | 443 ppm 431 ppm 435 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan are on, sending a warning SMS |
| 3 | 5 | 388 ppm 370 ppm 332 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan are on, sending a warning SMS |
| 4 | 10 | 287 ppm 330 ppm 276 ppm | Bring the gas source closer to The MQ-6 sensor | 10th seconds Led and the fan light up, sending a warning SMS |
| 5 | 15 | 222 ppm 230 ppm 199 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan do not turn on, do not send SMS alerts |
| 6 | 20 | 221 ppm 221 ppm 218 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan do not turn on, do not send SMS alerts |
| 7 | 25 | 192 ppm 221 ppm 211 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan do not turn on, do not send SMS alerts |
| 8 | 30 | 112 ppm 100 ppm 102 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan do not turn on, do not send SMS alerts |
| 9 | 35 | 98 ppm 98 ppm 93 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan do not turn on, do not send SMS alerts |
| 10 | 40 | 93 ppm 80 ppm 81 ppm | Bring the gas source closer to The MQ-6 sensor | The led and fan do not turn on, do not send SMS alerts |

3.5. Testing the Led indicator circuit
Led testing is done by connecting the anode on the Arduino output pin that passes through the resistor first and the cathode is connected to ground on Arduino. Then give the program logic the On-Off control program (High logic or Low logic). Led will be On if given High logic and Off if given Low logic.
3.6. Fan Testing
Tests carried out by giving a voltage to the fan Table 4 are the test result. In this circuit a relay component is added to disconnect and connect an electric current to the fan and serves to adjust the voltage needed by the fan.

| Voltage is given | Fan Condition |
|-----------------|---------------|
| 0 Volt DC       | Off           |
| 4.9 Volt DC     | On            |

3.7. Software Testing
Software testing this mean is program testing. The finished program is created using Arduino sketch, then uploaded to Arduino using a USB cable. After that, testing the program whether it is in accordance with good result or not by observing the outputsof the device such as a LED, fan, and GSM module.

3.8. Implementation of Tools
In the implementation of this tools, additional components are used, as figure 4, namely the addition of a relay to 2 channels which serves to regulate electrical power and control the flow of electricity connected to fan and light. The principle and method of operation of the circuit below is the same as the circuit in the prototype above the difference only the fan is replaced from the USB fan to the exhaust fan which is commonly used in the room, the plug-in is replaced by a plug-in that is directly connected to PLN electricity. Similiar to the fan, the lamp used in the circuit below is replaced by a large wattage lamp and the plug-in used is directly connected to PLN electricity.

![Figure 4. Series of Implementation](image)

4. Conclusion
With early detection of leaks on gas cylinders system using arduino based MQ-6 sensors, we can conclude:
4.1 In the MQ-6 sensor-based LPG gas leak early detection system using Arduino it has been successfully running according to an algorithm that has been designed and installed before in the test results and send a warning message to the specified number.
4.2 This system can detect gas faster in a closed room, on the contrary if in an open room the sensor
can detect longer because the level of contaminated gas will be immediately wasted into the air.

4.3 This application system is only a prototype and has not yet been tested for accidental leakage of LPG gas cylinders in relevant agencies which can cause explosions and fires.

4.4 In designing and making a prototype system, there are various kinds of weaknesses, both from the system planning and the equipment that has been made, it needs development including adding buzzer output that can alert the surrounding environment if there is a gas leak then adding a controller feature electrical switch, so that if a gas leak occurs it will automatically turn off and the last one will make a website or android based system to be able to see data in more detail and realtime.

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