IOT-BASED PROPANE AND BUTANE PRESSURE MEASUREMENT

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Received: 31, October, 2023 ***Revised: 23, November, 2023*** ***Accepted: 12, December, 2023***

ABSTRACT

Liquefied Potreleum Gas is a hydrocarbon containing two main gas components, propane, and butane, produced from oil and gas refineries Liquefied Potreleum Gas is a hydrocarbon containing two main gas components, propane, and butane, produced from oil and gas refineries. In this study, researchers will do the same thing in the IoT field but not in health monitoring but refer to Butane and Propane Gas Pressure Monitoring in LPG. Errors often occur when using an analog manometer (needle panel) when taking pressure measurements due to inaccurate measurements. There is a clear necessity for using digital manometers to ensure precise gas methane pressure measurement. The sensor receives data then the Arduino processes the data for conversion, the final results will be sent to the cloud using the esp8266 module and then forwarded to the smartphone as a monitoring user to see and also check gas conditions.

Keywords: Propane, Butane, MPX5700, Internet of Things

1. INTRODUCTION

Liquefied Petroleum Gas is a hydrocarbon containing two main gas components, propane, and butane, produced from oil and gas refineries (Dewi et al., 2022). Methane, found in chemical units within natural gas, can be employed as a cooking tool. That IoT is useful for providing infinite connections between various connected devices (Purmessur & Surroop, 2019). Kevin Aston, the inventor of the Internet of Things, said that IoT is an information and communication technology that continues to develop and improve through a global service architecture (Yao et al., 2022). IoT is a physical component connected to the Internet for communication and information under a specific protocol (Asrul et al., 2022).

The implementation of IoT in health monitoring systems continues to be developed by researchers as in previous studies using IoT systems, and their application in health monitoring. This technology continues to support new clinical and non-invasive systems (Papa et al., 2020). In this study, researchers will do the same thing in the IoT field but not in health monitoring but refer to Butane and Propane Gas Pressure Monitoring in LPG. Analog regulator manometers are often prone to measurement errors, leading to inaccurate readings of gas pressures. To avoid financial losses for consumers, it's crucial to have precise information on gas pressure. Many consumers purchase LPG gas cylinders based on their weight. Regulators that use analog manometers only provide approximate data and less accurate methane gas pressure readings. Therefore, it is necessary to read the methane gas pressure in order to produce more detailed and accurate measurements in accordance with actual conditions.

2. THEORY

2.1 Arduino

Arduino, an open-source tool, is intentionally crafted for straightforward programming, providing users with a seamless programming experience. Originally tailored for educational and professional use, Arduino fosters the construction of device systems interacting through sensors (Lu et al., 2023). The Input and Output functionalities of Arduino facilitate information retrieval and smooth communication, streamlining the transfer of data from sensors over the Internet (Kondaveeti et al., 2021). Arduino empowers users to effortlessly create systems harnessing sensor and device interconnectivity, establishing it as an adaptable platform for diverse applications (López & Lamo, 2023).

2.2 MPX5700

The MPX5700 sensor is designed to accurately measure the pressure entering it (Supriadi et al., 2022). With a measurement range of 15kPa to 700kPa or 0-101.5 Psi, it provides precise readings. The sensor's analog output ranges from 0.2 to 4.7 Vdc. However, it's important to note that the input data received by the sensor is not in its original form and requires conversion into methane gas units for proper interpretation and analysis (Riddick et al., 2022). This conversion process ensures that the pressure readings are accurately represented in methane gas units, facilitating the understanding of the data.

2.3 MIT App Inventor

MIT App Inventor stands out as a user-friendly Android app design platform, a creation of Google Labs. Its optimal functionality demands an internet connection (Megalingam et al., 2019). This platform revolutionizes app creation by enabling users to effortlessly drag and drop components, facilitating a visually intuitive design process. This user-friendly approach caters to beginners, eliminating the necessity for profound coding expertise (Dissanayaka et al., 2024). Through its visual interface, individuals can swiftly prototype and construct functional apps. This streamlines the development process, empowering users to transform their app concepts into reality efficiently.

2.4 Thingspeak Cloud

Thingspeak is a dedicated platform that seamlessly connects to the internet, enabling it to efficiently receive data and generate line graphs to visualize the data's progress. Equipped with centralized storage, the platform collects and securely stores data obtained from multiple devices (Ranjan et al., 2019). When connected to the internet, Thingspeak effectively receives and stores data transmitted by Arduino, forwarding it to the Thingspeak data storage. This integration allows for the seamless flow of information, enabling users to monitor and analyze data trends conveniently. With its robust capabilities, Thingspeak provides a reliable solution for data management and analysis in various applications and industries (Ullah et al., 2023).

3. METHOD

Recognizing the necessity for a real-time gas monitoring system to assist humans, the author introduces a proposed solution. This system utilizes an Arduino device connected to a sensor unit equipped with an MPX5700 sensor capable of accurately measuring gas pressure within an LPG cylinder. The collected data is then displayed with precision on an LCD screen and simultaneously transmitted to a dedicated server for storage. The design of the system focuses on providing a user-friendly interface to enable swift and efficient monitoring of residential gas conditions. You can find the schematic for this framework depicted below.

The input system that occurs on the arduino, methane gas pressure data received by the MPX5700 is read and forwarded to the arduino for data processing. The data received is data that is still in the form of original voltage, so it needs to be converted to pressure. After converting to pressure, the LCD will display the data it receives and then send it to the cloud thingspeak using the ESP8266 module as an internet connection link.

Once connected, the cloud serves as an online database, receiving and storing the data processed by the Arduino board. As a user, to access the data in the cloud, users can directly monitor the state of methane gas pressure through a smartphone in real time. For more details can be seen through the following scheme.

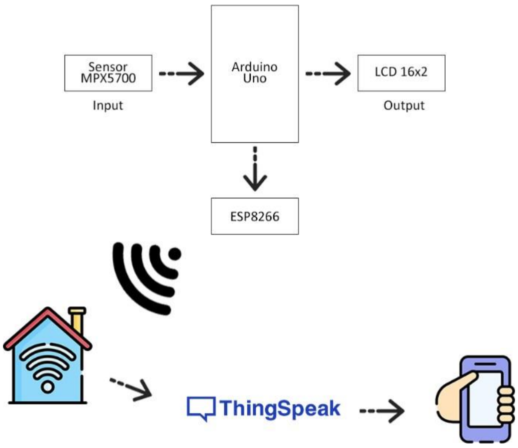

Figure 1. Design of iot-based gas pressure measuremen system

3.1 MPX5700 Sensor Circuit

The sensor in question has the capacity to measure gas pressure within the range of 0 to 700 kPa. The collected data is subsequently presented on an Arduino LCD. This feature is essential as it allows the system to ascertain if the gas pressure falls within the desired range or not. The system maintains optimal gas pressure levels by monitoring and displaying gas pressure readings, thereby enhancing the efficiency and safety of the system.

3.2 Lcd Circuit

The LCD serves as the sensor's output, displaying readings for more accurate, fast, and easily accessible information, enhancing the overall user experience with improved clarity and informative display.

3.3 Open and Locked Regulators

The regulator valves provide the option to either lock or unlock the regulator. When turned 180 degrees clockwise, the regulator is locked, allowing gas to flow into the reader sensor. In this position, the gas enters the sensor through the hose, which then connects to the stove. The diagram below illustrates this configuration.

P-ISSN : 2088-6705
E-ISSN : 2621-5608

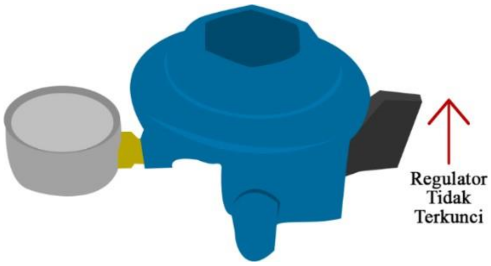

Figure 2. Open regulator

The open position means that the gas flow towards the hose to the stove is stopped by turning the regulator valve counterclockwise 180 degrees. The following sketch can be described.

Figure 3. Closed Regulator

3.4 MPX5700 Sensor Data Collection

To gather data from the sensor, it is interfaced with the regulator. In the data collection process, a regulator was added to the sensor and connected to a hose for methane gas flow. As the gas flows through the hose, the sensor detects it and produces a corresponding pressure reading. The accuracy of the data carried out, the sensor result data will then be compared with the original sensorless regulator.

3.5 Data Analysis

The MPX5700 sensor data results are compared with the regulator. This aims to see the accuracy of the data obtained by the sensor. The method done by applying gas pressure to the sensor will later be processed by the Arduino. Then, the arduino will display the reading data through the LCD then the data is used to compare with the manometer regulator.

4. RESULTS AND DISCUSSION

4.1 MPX5700 Testing

The MPX5700 test is used to measure the contents of gas cylinders more precisely. Researchers have noted that it is not known what is inside gas cylinders used in people's homes. Monometers that are used and sold only show round numbers and colors. The color also cannot give an accurate description of the actual contents. Even when the contents of the cylinder do not match the prescribed amount, such restrictions are often ignored. A gas cylinder usually weighs approximately 8kg with a content weight of 2.8 kg by looking at the results of the regulator which is listed in color only, if red is usually exhausted while green indicates filled but does not see the actual weight in accordance with the actual composition of the gas cylinder.

In accordance with gas composition regulations, the composition contained in the cylinder is limited to the maximum vapor pressure parameter of 145 psi.

Table 1. MPX5700 sensor test result

Volt	kPa	Psi	bar
0,2	28,089	4,073	0,3
4,5	697,861	101,190	6,9

Testing is done directly by testing the gas cylinders used at home, namely three kilograms. Researchers conducted research experiments on regulators that had been modified by replacing the manometer using an MPX5700 sensor. The initial gas state before the gas passes through the sensor or no pressure has been applied, the sensor gets a voltage of 0.2 volts (0.3 bar) this state is displayed through the LCD screen on the Arduino. An alarm will give a sign that the gas will run out if the sensor reads a pressure of less than 0.5 bar, the buzzer will sound and the LCD will display the state of the gas.

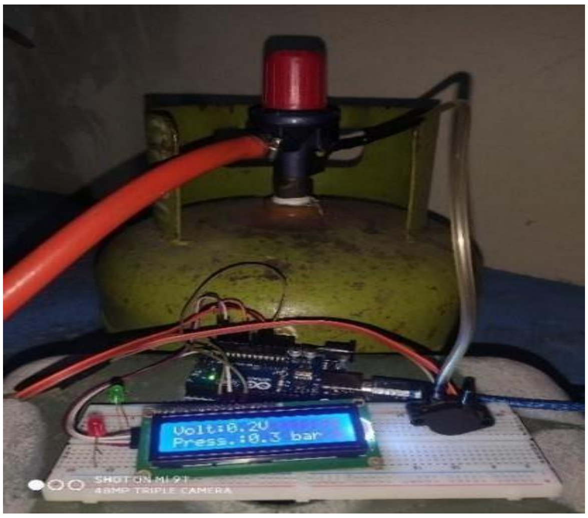

Figure 4. The sensor receives a voltage of 0.2 volt and a pressure of 0.3 bar

The pressure received comes from the sensor attached to the tube, then the data received is forwarded to the Arduino to be converted into pressure units according to the formula used. The next situation is to turn the regulator valve so that the sensor reads the state of the gas cylinder. At that time, information was received in the form of a voltage of 4.5 volts with a pressure of 7 bar, equivalent to 0.7 Mpa.

Figure 5. The sensor receives a voltage of 4.5 volt and a pressure of 7 bar

P-ISSN : 2088-6705
E-ISSN : 2621-5608

Researchers compared two models of manometer regulators, namely regulators with numbers (Figure 6) and regulators only with colors (Figure 8). In the first regulator trial, the needle manometer shows the direction to the number 7, providing information that the gas state is filled and vice versa when the valve state is not locked, the needle will point to 0. This comparison is carried out so that researchers can find out the accuracy and differences that exist in the two regulator models.

Figure 6. The first regulator with not locked valve conditions

Figure 7. Regulator with valve condition after locking

Then the second regulator (color), the condition of the tube filled with the regulator needle directs in position 8 (yellow color) while if the valve is unlocked the needle is in position 0 (red color).

Figure 8. Second regulator with valve conditions not yet locked

Figure 9. Second regulator with valve condition after locking

The information received when the sensor reads the incoming pressure is the original data (value) of the sensor but it needs to be converted into volts or units of arduino voltage between 0 - 5 volts:

$$\text{Volts} = V * (5 / 1023) \quad (1)$$

The result of pin A0 is as an analog value reader from the arduino. This is done because it is necessary to find the appropriate voltage value from the arduino. Then, the results of the value are converted into pressure units with the following formula:

$$\text{kpa} = ((\text{Volts} /5) - 0.04) / 0.0012858 \quad (2)$$

$$\text{psi} = \text{kpa} * 0.145 \quad (3)$$

The datasheet obtained from the sensor after conversion is 15-700 kpa, the value of 1 kpa is equal to 0.145 psi. According to the barometer, 1 psi produces 6.89 kpa. The following datasheet is obtained by the sensor after conversion:

Table 2. MPX5700 sensor testing with regulator

First Regulator (Whithout Unit)	Second Regulator (Unit)	MPX5700 Sensors (bar)		Error et		Et^2 Squared Error	
0	0 bar	0,3	0,3	-0,3	-0,3	0,09	0,01
7	8 bar	6,9	6,9	0,1	1,1	0,09	1,21
Sum of Squared Error						0,18	1,22
Mean Squared Error (MSE) Value						0,09	0,61

Comparison between the first, second regulator and MPX5700 Sensor, this aims to find the difference in the accuracy of a system. The first regulator trial was found to be in accordance with the results on regulators 0 and 7. The second trial on the color regulator resulted in accordance with the state of the regulator. Then the MPX5700 sensor obtained data results of 0.3 bar this is because the sensor has a voltage obtained and read by Arduino so that this voltage is considered as 0. After the regulator valve is locked, the gas will flow into the sensor and the result is 6.9 bar. This result is actually from the acquisition of the formula that has been entered in the Arduino system.

To find the error value, first calculate the error to obtain the comparative results between the actual and the results obtained. The error formula can be done with the following formula:

$$Et = Xt – Ft \quad (4)$$

Information:
et = error value
Xt = data actual in period t Ft = data results in period t

Then find the error value of the two values by squaring the error value. The error calculation formula is a parameter to test the accuracy of the results of the research conducted. The smaller the value obtained, the more accurate the research results. The Mean Square Error (MSE) formula is as follows:

$$MSE = \sum Et2 / n \quad (5)$$

Information:
Et2 = squared error value n = lots of data

The results obtained based on the error value, it can be concluded that the regulator test results using the MPX5700 sensor have accurate results.

4.2 Testing Lcd 16x2

Lcd testing is done to prove that the lcd is functioning properly. Lcd can function in this system by displaying the sensor result data received and converted.

Figure 10. Testing lcd 16x2

Lcd displays according to the results of the program ordered on the Arduino. In the lcd testing image written "Gas contains 7.0 bar", it is confirmed that the lcd can run and function properly.

4.3 Android App Testing

Smartphone trials are carried out to see the condition of the gas state received from the cloud (Thingspeak). Through the app inventor application, making this application can be easier because it uses a block system (drag and drop).

Figure 11. Android app testing

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

The MPX5700 sensor can measure methane gas pressure well and produce accurate numbers in its tests. Then the application of the internet of things system in this system can also run well. The sensor receives data then the arduino processes the data for conversion, the final results will be sent to the cloud using the esp8266 module and then forwarded to the smartphone as a monitoring user to see and also check gas conditions.

5.2 Suggestion

This development can be continued in the future if one day there is the same research as this system but it needs to be added to control the system so that communication can occur between the system and the user.

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