Gas Analyzer System Design in Determining Natural Gas Composition Based on IoT

Jaka Dwi Prayugo[1], Roni Heru Triyanto[2,*], Suka Handaja[3]
[1,2,3] Program Studi Teknik Instrumentasi Kilang, Politeknik Energi dan Mineral Akamigas, Cepu Jawa Tengah, Indonesia 55312

[*]Corresponding Author: roni.triyanto@esdm.go.id (Roni Heru Triyanto)

Info Artikel
Histori Artikel:
Diterima berkas: 1 Mei 2024
Direvisi: 25 Mei 2024
Disetujui terbit: 2 Juni 2024

Keyword:
Gas analyzer
Natural gas
Gas composition
Internet of Think

ABSTRACT
In the gas industry, a gas composition measurement system is needed to determine the compounds contained in the gas as a reference for other utilisation. In addition, it is used to measure the energy level contained in the gas. Because the tool is expensive and difficult to reach, the author designed a gas analyser system that is used to measure gas composition in a simple way. The tool has 3 main processes, namely gas injection which aims to inject sampling gas, namely natural gas to be measured and helium gas as a mobile phase to carry sampling gas to the next process. The second process is heating which aims to break down the compounds contained in the sampling gas according to the compounds contained in the gas. Then the last process is reading the gas composition using MQ-2, MQ-5, and MQ131 sensors so that the result of methane compounds up to hexane are obtained in the form of mole percentage. This tool will be compared with the data report from PGN Bojonegoro to determine the accuracy of the reading of this tool. So that the average error result is 0.961%.

1. INTRODUCTION

Natural Gas is a world energy source that tends to be clean and efficient which is used in applications such as transportation, electricity distribution and industry. The most important aspect in natural gas is monitoring and controlling the quality of the gas used. Determining gas composition is very important because it involves several keys to ensuring efficiency and sustainability of gas use (Pranata, 2019). The tool used to measure gas composition in this research is a gas analyzer. The tool can measure the gas content contained in the gas analyzer, including methane, ethane, propane and butane (Fauziyah & Gigih, 2020).

This research aims to design and build a microcontroller-based gas analyzer that can be used to determine the composition of Natural Gas quickly and accurately. With this tool, it is hoped that it can help Natural Gas users to monitor the quality of the gas they use. This research will discuss the design steps, selecting the right sensor, as well as the analytical methods used to determine the composition of Natural Gas gas. Apart from that, this research will also consider various factors that can influence the analysis results, such as temperature, pressure and humidity.

The results of this research are intended as a learning method as well as the author's experimental form regarding the gas analyzer used which is able to detect the composition of the gas used. Thus, this research has significant relevance in the context of safe use of gas energy, environmental protection and sustainable technology development. Apart from that, the development of this tool can also make a positive contribution to the progress of gas measurement technology which can be applied in various other applications

2. METHOD

The block diagram of this system is based on the injection process, compound breakdown, gas composition detection, and recording on Blynk as interfacing. The results of the process readings are adjusted to the ASTM D1945 standard which regulates gas composition constants. The following is a block diagram of the gas analyzer process. In the block diagram below, there is a MAX6675 module used as a converter or transmitter which is used to change the signal sent via the thermocouple and received by the MAX6675 and

sent back to the ESP 32. This is needed to display the actual temperature reading results. Apart from that, ADS1115 is used for the MQ sensor input.

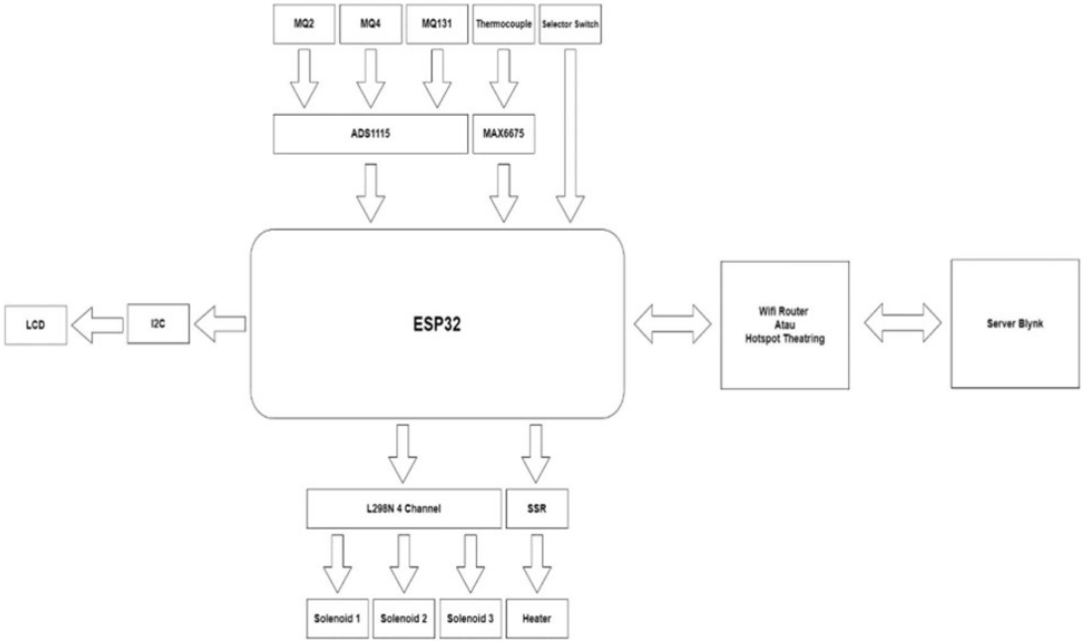

Fig. 1. Proposed gas analyzer system architecture

2.1 *Hardware design*

The design consists of several components that support the gas composition measurement process. The hardware design consists of injected LPG gas and carrier, column components, detector and recorder. The designs are connected using cables so that they can be initialized between one another. The following is a form of hardware design.

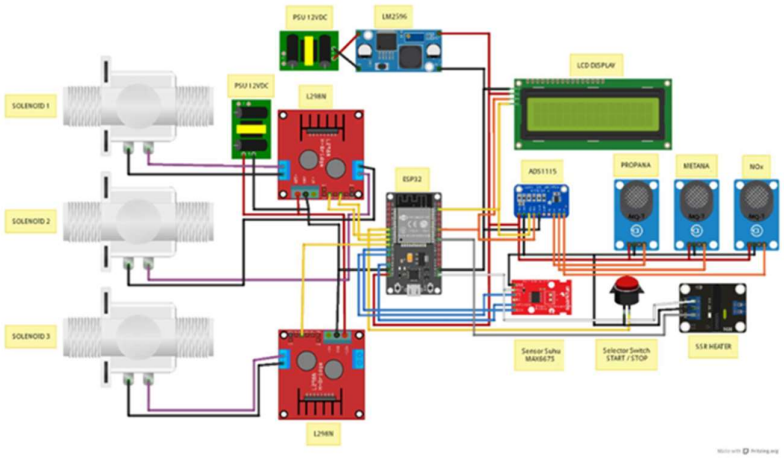

Fig. 2. Proposed gas analyzer system hardware configuration

2.2 *Software design*

Software design focuses on how the tool can receive results that have been read by the detector and then interface with Blynk. After the results of the compound separation process in the separation column have been

carried out, the composition of the lighter gas will be read first by the detector used. The detector will save the reading results and then send them to Blynk.

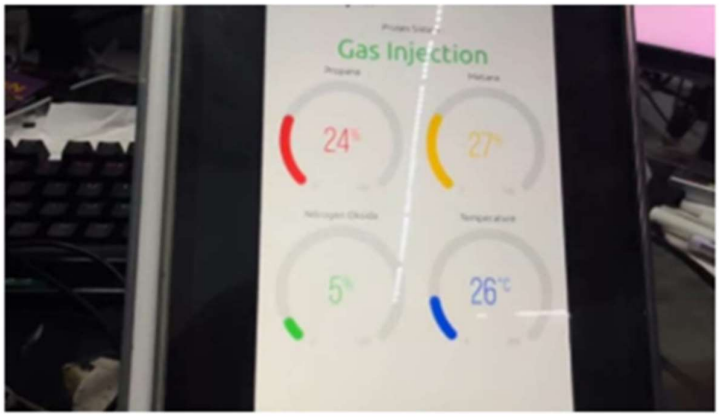

Fig. 3. HMI display of gas analyzer system using Blink

3. IMPLEMENTATION SYSTEM

The tool working system is divided into 3 systems, namely the injection system, heating and measurement results. In the injection system there are 2 gas streams, each of which is used to inject sampling gas and helium gas. The sampling gas used is natural gas while helium gas is used as a carrier gas in the injection system. To regulate the injection system, a timer is used to set 5 seconds for each sampling and helium injection to regulate the flow before it enters the heating system. For the next process, enter the heating system. This process occurs in a box heater which contains a thin fused silica column which is used as a compound breaking container. This heating process is regulated up to 70˚C using an on-off control system.

Fig. 4. Hardware implementation, the blue box is the gas reactor and the white box is the electric panel.

After going through the heating process, the compounds will be broken down according to the melting point of each compound so that the composition contained therein can be known. This can be measured through a reading and measurement process using an MQ sensor according to the gas being measured. The MQ sensor can measure the composition of each compound without being disturbed by other gases because the placement of the sensor is protected from gases in the atmosphere.

4. MEASUREMENT DATA

The injection process is the main process where a sampling of natural gas will be injected into the injection port and will be pushed by helium carrier gas as a carrier and breaking medium during the heating process. After carrying out the injection process, it continues with the heating process. In this process, the sampling of

gas that enters and is carried by the carrier gas will be split according to the melting point of each gas until it is separated according to the compounds contained. This process takes 1 minute and will continue to repeat itself. This process must be carried out so that the gas contained in the gas sampling is more accurate and in accordance with the existing gas composition.

Table 1. Results of analysis of one of the natural gas samples

No	Composition Gas	Value (%)
1	Methana	88.81
2	Ethana	3.81
3	Propana	1.905
4	Butana	0.905
5	Pentana	0.952
6	Heksana	0.476
7	Nitrogenoksida	3.143
	Total	100

Based on the values above, it is known that the largest composition contained in natural gas is methane gas at 88.81%. The above results are strengthened by evidence from Blynk monitoring images in accordance with the image below.

Fig. 5. Display of analysis results on HMI

5. ANALYSIS

Basically, the value of the Natural Gas composition has different results according to the natural gas formation process and the gas processing carried out. However, the composition of natural gas has a chain of compounds that have similarities, namely Methane, Ethane, Butane and Hexane. In this case, the Natural Gas used for sampling to determine the resulting composition was taken from PGN Bojonegoro which functions as kitchen stove fuel. Therefore, it is necessary to calculate the error for determine the level of accuracy of the tool that has been designed. So this becomes a reference for the level of success of this project design. Based on the data contained in PGN Bojonegoro, the following results were obtained.

Based on the comparison results above, it is known that the reading values contain error results which are listed in the table above. The error value is influenced by several factors, including the sensor used being less accurate or sensitive, the heating process not running optimally, gas sampling that is less pure and so on. So the error size is in the range of 0.5% to 3% according to the reading of each existing gas composition and the average error obtained by reading the gas is 0.961%.

Based on the data above, the error results obtained by comparing the designed tool and the average daily gas results of PGN Bojonegoro are as follows.

Table 2. Measurement results vs measurement values by PGN Bojonegoro

No	Composition Gas	Measurement Value (%)	PGN Bojonegoro (%)	Error (%)
1	Methana	88.81	91.0064	2.20
2	Ethana	3.81	3.2283	0.58
3	Propana	1.905	1.003	0.90
4	Butana	0.905	0.433	0.47
5	Pentana	0.952	0.0174	0.93
6	Heksana	0.476	0	0.48
7	Nitrogenoksida	3.143	4.312	1.17
	Total	100	100	

4. CONCLUSION

The conclusions from the research results on the design and construction of the gas analyzer system as follows:

The results of the Gas Analyzer design are in accordance with the process to start from the gas injection process which consists of a carrier gas helium and Natural Gas, followed by the heating process, then enter to the stage of reading the results through the sensors used. Determine whether natural gas can be produced through the process of heating the gas sampling contained in the Box Heater. After Each compound is broken down and the resulting compound is a gas composition will be captured by the gas sensor detector used so that it can monitored on Blynk. The results of the gas analyzer readings are in accordance with the composition of the sampling gas namely natural gas consisting of the composition of methane, ethane, propane, butane, pentane, and hexane. The largest composition contained in natural gas, namely methane gas, is 88.81% Comparison results between data from PGN and the designed tool has an error value. The error value is obtained from various factors according to the explanation. The results of the error value have an average error value of 0.961%.

REFERENCES

This guide contains examples of common types of APA Style references. Section numbers indicate where to find the examples in the Publication Manual of the American Psychological Association (7th ed.).

[1] Ardiansyah, F., Misbah, & S., P. P. (2018). Sistem Monitoring Debu Dan Karbon Monoksida Pada Lingkungan Kerja Boiler Di Pt. Karunia Alam Segar. IKRA-ITH TEKNOLOGI: Jurnal Sains & Teknologi, 2(3), 62–71. https://journals.upi-yai.ac.id/index.php/ikraith-teknologi/article/view/333

[2] Asmazori, M. (2021). Rancang Bangun Alat Pendeteksi NOx dan CO Berbasis Mikrokontroler ESP32 dengan Notifikasi Via Telegram dan Suara. JITCE (Journal of Information Technology and …. http://jitce.fti.unand.ac.id/index.php/JITCE/article/view/134

[3] BahooToroody, A., Abaei, M. M., Arzaghi, E., & ... (2019). Multi-level optimization of maintenance plan for natural gas system exposed to deterioration process. Journal of Hazardous https://www.sciencedirect.com/science/article/pii/S0304389418308380

[4] Das, S., Sarkar, C. K., & Roy, S. (2018). Development of integrated microsystem for hydrogen gas detection. IET Circuits, Devices and Systems, 12(4), 453–459. https://doi.org/10.1049/iet-cds.2017.0243

[5] Dzulkifli, M., Komarudin, A., & ... (2021). Prototype Smarthome Security System Using ESP8266 Based Internet of Things (IoT) By Blynk Application. Jurnal Elektronika …. http://elkolind.polinema.ac.id/index.php/elkolind/article/view/275

[6] Energi, K., Sumber, D. A. N., Mineral, D., Energi, P., & Mineral, D. A. N. (n.d.). RANCANG BANGUN AUTOMATIC METER Oleh: November 2022.

[7] Fauziyah, I. N., & Gigih, M. B. (2020). Rancang Bangun Alat Pendeteksi Kebocoran Gas LPG Menggunakan Sensor MQ-6 Berbasis Arduino. Jurnal Ilmiah Intech: Information …. http://dev.umus.ac.id/index.php/intech/article/view/185

[8] Hartanto, S., & Irhamni, M. (2019). SAFETY SMART HOME BERBASIS MIKROKONTROLER ARDUINO UNO ATMEGA328P DAN SMOKE DETECTOR MQ-2. In Jurnal Ilmiah Elektrokrisna. journal.teknikunkris.ac.id. https://journal.teknikunkris.ac.id/index.php/elektro/article/download/83/74

[9] Mostafavi, S. M., Rouhollahi, A., (2014). Separation of Aromatic and Alcoholic Mixtures using Novel MWCNT-Silica Gel Nanocomposite as an Adsorbent in Gas Chromatography. Journal of …. https://jnanoanalysis.tms.iau.ir/index.php/en/journal/article_531019.html

[10] PERMATASARI, A. (2019). PENGEMBANGAN ALAT PERAGA LAMPU SENSOR BERBASIS ARDUINO UNO PADA MATERI ENERGI. repository.radenintan.ac.id. http://repository.radenintan.ac.id/7418/1/SKRIPSI.pdf

[11] Pranata, D. A. D. (2019). PROTOTYPE SISTEM PENDETEKSI KEBOCORAN LIQUIFIED PETROLEUM GAS BERBASIS ARDUINO DAN CALL GATEWAY. Ubiquitous: Computers and Its Applications …. http://e-journal.umaha.ac.id/index.php/ubiquitous/article/view/467

[12] Rabbani, F., Resab, M. K., & Wicaksono, R. (2019). Sistem Pengamanan Brankas Berbasis GPS Tracking & IoT (Internet of Things): Jurnal Otomasi, Kendali http://journal.unj.ac.id/unj/index.php/autocracy/article/view/14354

[13] Sanchez, M., Amores, E., Abad, D., Rodriguez, L., (2020). Aspen Plus model of an alkaline electrolysis system for hydrogen production. International Journal of https://www.sciencedirect.com/science/article/pii/S0360319919345276

[14] Setyawan, A., Prabowo, M. N., & Suseno, J. E. (n.d.). RANCANG BANGUN SISTEM KEAMANAN PINTAR PADA PINTU KAMAR MENGGUNAKAN RFID, PASSWORD DAN ANDROID BERBASIS ARDUINO UNO. BERKALA FISIKA. https://ejournal.undip.ac.id/index.php/berkala_fisika/article/view/30617

[15] Trucksess, M. W., Brumley, W. C., & ... (1984). Rapid quantitation and confirmation of aflatoxins in corn and peanut butter, using a disposable silica gel column, thin layer chromatography, and gas chromatography …. Journal of the Association …. https://academic.oup.com/jaoac/article-abstract/67/5/973/5699077

[16] Wang, J., Bryant-Genevier, J., Nuñovero, N., & ... (2018). Compact prototype microfabricated gas chromatographic analyzer for autonomous determinations of VOC mixtures at typical workplace concentrations. In Microsystems & nature.com. https://www.nature.com/articles/micronano2017101