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CO2 detection system in mixed gas using MQ-135 sensor

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ABSTRAK

Peningkatan gas CO_2 terjadi sangat signifikan akibat penggunaan bahan bakar fosil, industri, kebakaran hutan, letusan gunung berapi dan gas alam yang mengakibatkan pencemaran udara. Bahaya gas CO_2 bagi manusia dapat menyebabkan sakit kepala, berkeringat, penglihatan kabur, tremor, dan kehilangan kesadaran setelah terpapar selama lima sampai sepuluh menit. CO_2 adalah gas beracun yang secara fisik tidak berwarna dan tidak berbau. Sifat ini menyebabkan banyak manusia yang tidak menyadari keberadaan gas ini, sehingga terpapar dan membahayakan kesehatan. Oleh karena itu, diperlukan suatu sistem pendeteksi gas CO_2. Kesulitan yang terjadi dalam pendeteksian gas CO_2 adalah ketika gas tersebut bercampur dengan gas lain yang memiliki sifat material yang sama. Pada penelitian ini dirancang sistem pendeteksi gas CO_2 untuk mendeteksi gas yang bercampur dengan gas lain menggunakan sensor MQ-135. Sistem yang telah dirancang dan dibangun kemudian dibandingkan dengan alat standar yaitu dragger xm-7000. Data uji yang dianalisis menggunakan regresi linier menunjukkan hasil yang sesuai dengan 2 nilai R = 0,9896 dengan persamaan konversi y = 0,0389x-76.086. Dengan hasil tersebut memberikan peluang baru dalam pengujian CO2 pada campuran gas yang lebih mudah dan murah.

Kata kunci: Deteksi CO_2, Gas Campuran, MQ-135

ABSTRACT

The increase in CO2 gas occurred very significantly due to the use of fossil fuels, industry, forest fires, volcanic eruptions and natural gas resulting in air pollution. The dangers of CO_2 gas for humans can cause headaches, sweating, blurred vision, tremors, and loss of consciousness after exposure for five to ten minutes. CO2 is a poisonous gas which is physically colorless and odorless. This characteristic causes many humans to be unaware of the existence of this gas, so that it is exposed and endangers health. Therefore we need a CO2 gas detection system. The difficulty that occurs in the detection of CO2 gas is when the gas is mixed with other gases that have similar material properties. In this research, a CO2 gas detection system is designed to detect the gas when it mixes with other gases using the MQ-135 sensor. The system that has been designed and built is then compared with a standard tool, namely the xm-7000 dragger. The test data analyzed using linear regression showed the results in accordance with 2the value of R = 0.9896 with the conversion equation y = 0.0389x-76.086. With these results provide new opportunities in testing CO2 on gas mixtures that are easier and cheaper. .

Keywords: CO_2 gas detection, mixed gas, MQ-135

1. INTRODUCTION

The use of fossil fuels, industry, forest fires, volcanic eruptions and toxic natural gas are the causes of air pollution. One of the parameters of indoor or outdoor air quality is carbon dioxide (CO2). The dangers of CO2 gas for humans are headache, sweating, blurred vision, tremors, and loss of consciousness after exposure for five to ten minutes [1]–[5]. Physically CO2 is colorless and odorless, so many people are exposed to the gas because they do not know its existence[6]. Research on CO2 is becoming popular at this time, because many studies state that there is a correlation between CO2 released by human respiration and infection with the Covid-19 virus [7], [8]. Instrumentation for detecting CO2 has been developed, but the instrument is still limited and only certain laboratories have it because it is relatively expensive[9]. New challenges arise in CO2 detection systems when

CO_2 gas mixes with other gases. CO_2 gas becomes difficult to detect because some gases have optical absorption properties similar to CO_2, such as CH_4, H_2O and NO_2. Therefore, instrumentation is needed to detect CO_2 gas when mixed with other gases.

In this study, the design of instrumentation for CO_2 gas detection when mixed with other gases was carried out using the MQ-135 sensor. The MQ-135 sensor is a type of solid electrolyte sensor that works based on electrochemical properties. This detection system uses an electrochemical method based on the nature of the sensor material used. The electrochemical gas sensor generates an electric current when the target gas diffuses into the sensor cell and when it enters the electrolyte oxidation occurs at the electrode. The amount of current generated is proportional to the ratio of the target gas volume[10], [11]. In general, in the design of an electrochemical gas detection system, a special filter system is used to filter out interfering gases (other than the target gas) [12]. Therefore, there are various kinds of gas sensors with various types of materials according to the target gas to be detected. One example of a CO_2 gas sensor used is the MQ-135[13]–[15]. This sensor has advantages such as high sensitivity, a more affordable price and relatively easy to integrate into a circuit system[16]–[19].

The test gas used was obtained from a replica gas-producing engine [20]. Where, the machine produces a mixture of CO_2, CO, CH_4, H_2S and SO_2 gases. The sensor is integrated with the microcontroller and the results are displayed on the computer monitor. The novelty in this research is the system designed to detect CO_2 when mixed with CO_2, CO, CH_4, H_2S and SO_2. This will be confirmed by calibrating the designed system with a standard gas test tool, namely the Dragger Xm-7000.

2. METHOD

CO_2 detection system design includes hardware design and software design. Hardware design is the design of electronic modules and interfaces which include MQ-135 sensors, microcontroller (using Arduino Mega) and personal computers. The system design block diagram is shown in Figure 1.

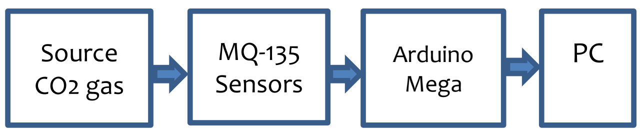

Figure 1. Block diagram of CO_2 gas detection system

Software design includes the preparation of data acquisition programs on the Arduino IDE. In this research, additional software is used, namely CoolTerm which is used to display the test result data in real-time[21], [22]. The software is an interface system used to display the incoming data in the form of a data table so that it is more interactive and easier to understand. The Arduino IDE display is shown in Figure 2, while the CoolTerm display is shown in Figure 3. Integration of hardware and software system to data analysis is carried out in several stages they are Combining hardware and software systems, testing the device, analyzing data to get test results. Data analysis used to use linear regression approach.

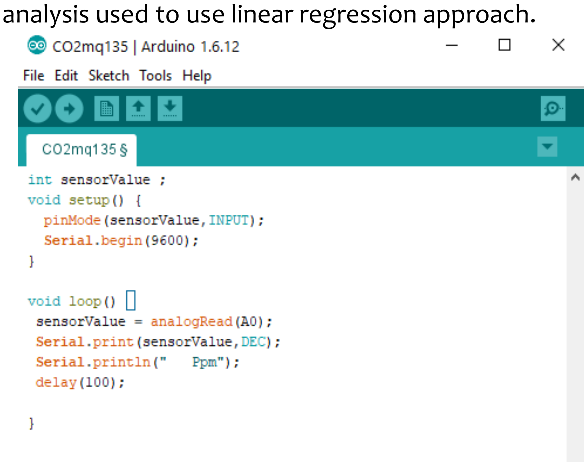

Figure 2. Arduino IDE display

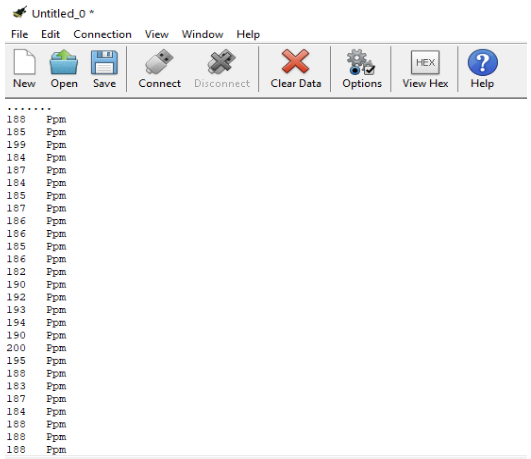

Figure 3. CoolTerm display

3. RESULTS AND DISCUSSIONS

The photograph of the design testing of the CO_2 gas detection system is shown in Figure 5.

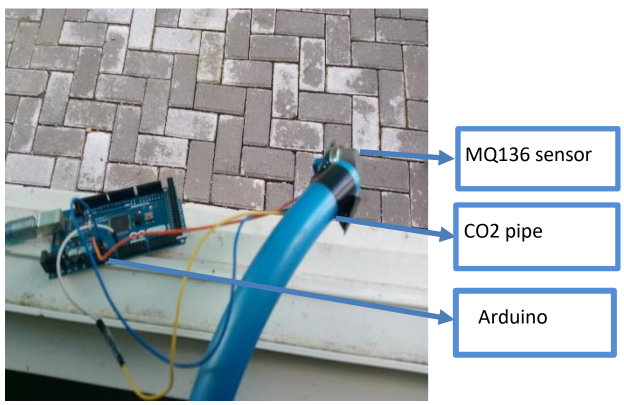

Figure 5. CO_2 detection testing system photograph

At the beginning of the test, the designed system has been tested on the gas output produced by the gas-producing engine. This test uses a standard tool to compare the accuracy of the designed system, namely the Dragger Xm-7000[20]. The appearance of the Dragger Xm-7000 is shown in Figure 6.

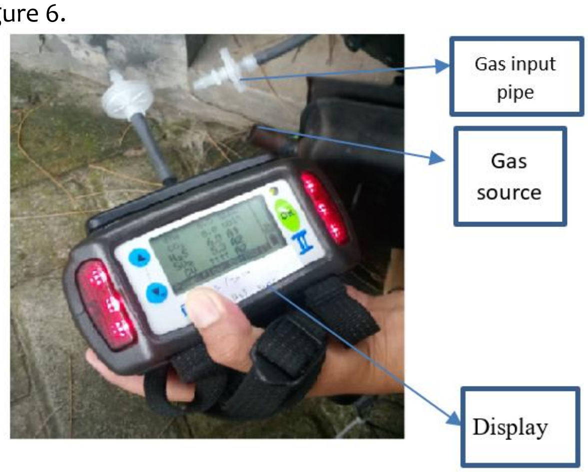

Figure 6. Dragger Xm-70000 display

The result of the gas detection test system designed to use the MQ-135 with Dragger Xm-7000 are shown in Table 1.

Table 1. Gas detection test results using MQ-135 and Dragger Xm-7000

Dragger data (ppm)	MQ136 data (ppm)
6000	134
8000	259
10.000	312
12.000	398
14.000	474
16.000	532

Table 1 shows that the increase in CO2 gas concentration in the test results using Dragger Xm-7000 also occurs in the test results using MQ-135. From the data, a graph of the data relationship of the Dragger Xm-7000 test results is made with a detection system using the MQ-135 sensor. This is done to obtain the conversion value of the ADC value generated by the MQ-135 sensor. The conversion will produce a linear equation that is used to be included in the Arduino IDE program in the next test. The graph of the relationship between Dragger's test results and test results using MQ-135 is shown in Figure 7.

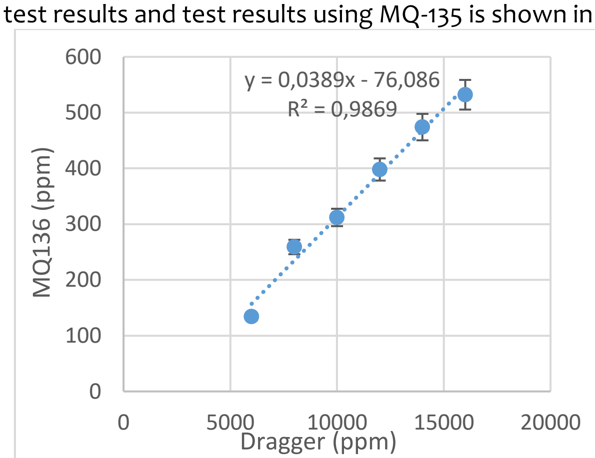

Figure 7. Graph of the relationship between Dragger test data and a detection system using MQ136

The graph in Figure 7 shows that the conversion value is obtained with the linear equation y = 0.0389x – 76.086 with a value of R2 = 0.9869. This value proves that the difference in test results is still in the relatively small error range. The next test is carried out by entering the conversion value of the linear equation into the IDE program [23], [24]. The test results obtained with five test variation data as shown in Table 2.

Table 2. Comparison of CO2 Dragger Xm-7000 and MQ136 test results after conversion

Dragger data (ppm)	MQ136 data (ppm)
6000	5400
8000	8614
10,000	9976
12,000	12,187
14,000	14,141

Table 2 shows that the largest deviation is at the measurement of 8000 ppm at 614 ppm and the smallest deviation from the 10,000 ppm measurement is 24 ppm, the average deviation of the five data is about 300 ppm. These deviations are included in relatively small deviations because CO2 levels of 300 ppm to 500 ppm are levels that can still be tolerated[4], [25]. Therefore, it can be concluded that the CO2 gas detection system using MQ-135 can work quite well.

4. CONCLUSION

The design of a CO2 gas detection system with MQ136 sensor using Arduino Mega shows a fairly good test result. The test results of the system designed with Dragger Xm-7000 show a linear relationship with R2 = 0.9896. While the average deviation resulting from the test is 300 ppm.

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